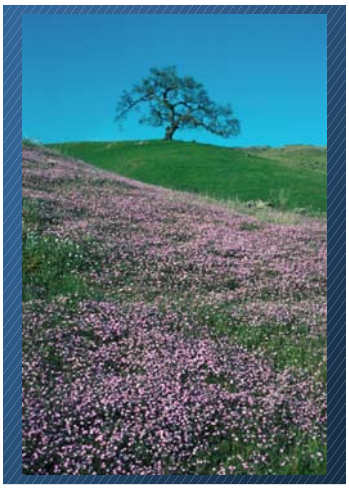

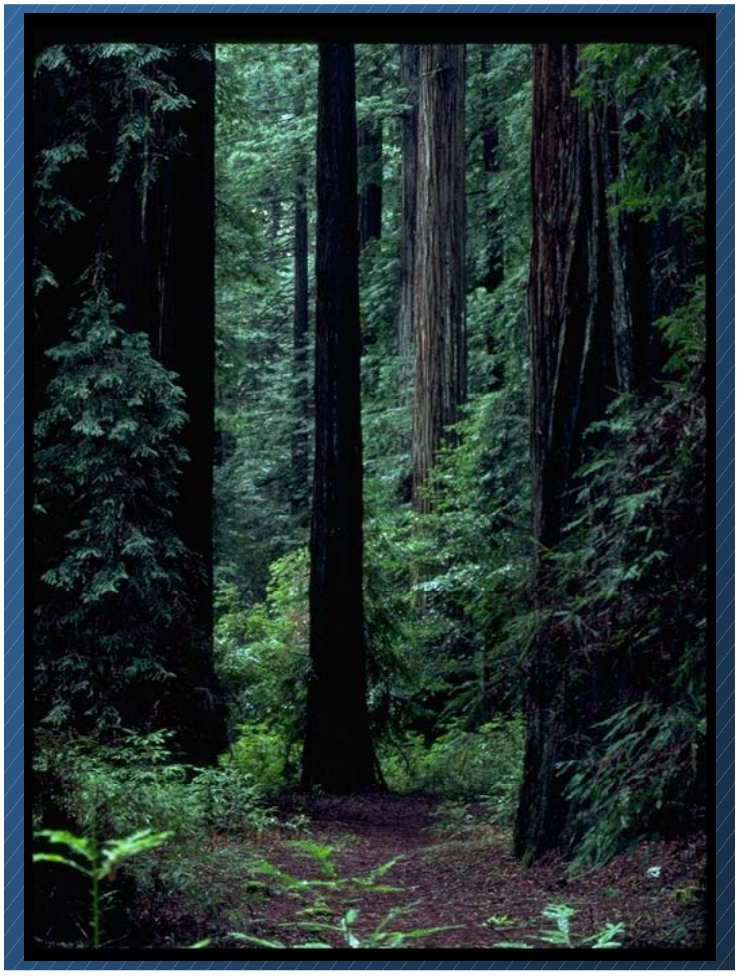

San Francisco Bay Area Gap Analysis:

A Preliminary Assessment of Priorities for Protecting Natural Communities

Coastal Conservancy

San Francisco Bay Area Gap Analysis:
A Preliminary Assessment of Priorities for Protecting Natural Communities

California State Coastal Conservancy
Oakland, California

Principal Analyst and Author:
Cathryn Wild, November 2002

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Executive Summary

The Coastal Conservancy completed this San Francisco Bay Area Gap Analysis in November 2002 in the hope that it would be a useful tool for regional conservation planning. This document presents the results of that analysis after scientific peer review.

The Conservancy undertook this project to achieve the following four goals:

1) Determine the degree of protection for natural communities provided by the existing system of open-space lands in the Bay Area.
2) Provide a preliminary assessment of this protection by comparing the present extent of protection to target levels of protection.
3) Use the assessment of protection to suggest priorities for conservation of natural communities.
4) Stimulate a regional discussion of conservation planning to determine what adequate protection of natural communities would look like.

"Gap analysis" was chosen as the best means of meeting these goals. It is a preliminary step in a comprehensive and systematic approach to conservation planning that identifies biotic communities or target species that are not adequately represented in currently protected land. Using a Geographic Information System (GIS), three categories of data are overlaid: land cover (includes plant communities), wildlife (provides predicted or known distribution of wildlife habitats), and stewardship (provides status of protection for all lands). The juxtaposition of the layers reveals which natural communities are found within the existing system of protected open space lands, and allows for quantification and other analyses of those natural communities found to be unprotected (the "gaps").

The Bay Area gap analysis followed the standardized procedures of the United States Geologic Survey (USGS) National Gap Analysis Program (U.S. Geological Survey 1986), and used the land cover layer developed by the California Gap Analysis Program (Davis et al. 1998) to depict the location and extent of existing natural communities in the Bay Area (in this report, "natural communities" refers to the natural, terrestrial plant communities discussed and described, but also, by extension, the species they may support). The Bay Area gap analysis did not develop a wildlife layer *per se*, but a wildlife layer could be developed from the data presented in this project. An original stewardship layer for the Bay Area was developed by GreenInfo Network in 2001.

The land cover and stewardship layers were compared using GIS to determine what percent of each natural community is protected by existing open space lands. This degree of protection was compared to two target percentages, or benchmark levels of protection: 100% and 20%. Communities with documented statewide declines exceeding 80% were compared to a target level of 100%, and the remaining natural communities were compared to a target level of 20%. These target numbers could be changed, however, and new results generated from the information included in this report.

Bay Area natural communities were then prioritized based on four factors: 1) endemicity to the region, 2) local threat by development, 3) a combination of statewide rarity and threat level, and 4) level of statewide protection.

The analysis revealed that protected open space lands comprise 16.1% of the San Francisco Bay Area (compared to 18% statewide) and include 62 natural communities (compared to 194 statewide).

- 24 communities meet the target of 20% protection.
- 38 communities do not meet the target percentages, and thus are conservation "gaps." Eight of these communities have documented statewide declines in excess of 80%, but do not meet the target of 100% protection in the Bay Area.
- The prioritization analysis indicates that local development threatens five of the 38 communities that do not have adequate protection (Monterey Pine Forest, Coastal and Valley Freshwater Marsh, Venturan Coastal Sage Scrub, Great Valley Cottonwood Riparian Forest, and Non-native Grassland). Two of the five threatened communities (Coastal Prairie, Northern Coastal Salt Marsh) have documented declines in excess of 80%.

The results of the San Francisco Bay Area Gap Analysis can be used to educate the regional conservation community about the successes and limitations of the current conservation reserve system, including which communities are in need of more protection and which should be future conservation priorities. This gap analysis could also be used in the preliminary stages of selecting future open-space areas. The Coastal Conservancy encourages a comprehensive regional conservation planning process, which would build upon the results of this gap analysis to improve the conservation of ecoregional diversity in the San Francisco Bay Area.

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Abbreviations and Acronyms

CNDDB	California Natural Diversity Database
DFG	California Department of Fish and Game
EBRPD	East Bay Regional Park District
Km^2	Square kilometers
NHD	Natural Heritage Division, California Department of Fish and Game
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1.0 Introduction

This regional gap analysis was conducted by the San Francisco Bay Area Conservancy Program (Bay Program) of the California State Coastal Conservancy (see inset) with the assistance of many other organizations in the Bay Area (see Acknowledgments). The Conservancy hopes that this document will help Bay Area conservationists in their efforts to protect regional biodiversity.

The goals of the project were to:

1. Determine the degree of protection for natural communities provided by the existing system of open-space lands in the Bay Area.
2. Provide a preliminary assessment of this protection by comparing the present extent of protection to target levels of protection.
3. Use the assessment of protection to suggest priorities for conservation of natural communities.
4. Stimulate a regional discussion of conservation planning to determine what adequate protection of natural communities would look like.

"Gap analysis" was chosen as the best means of meeting these goals. It is a preliminary step in a comprehensive and systematic approach to conservation planning that identifies biotic communities or target species that are not adequately represented in currently protected land. Using a Geographic Information System (GIS), three categories of data are overlaid: land cover (includes plant communities), wildlife (provides predicted or known distribution of wildlife habitats), and stewardship (provides status of protection for all lands). The juxtaposition of the layers reveals which natural communities are found within the existing system of protected open space lands, and allows for quantification and other analyses of those natural communities found to be unprotected (the "gaps").

Gap analysis has been frequently used in the design and selection of nature reserves. The gap data are used to locate potential reserve sites that support either target communities or the maximum number of plant communities. Gap data were used in Florida to develop a conservation system of linked nature reserves that will include half the state's area, and it is already 50% complete (Hoctor et al. 2000). In Indiana and Illinois, gap data were visually analyzed to select potential sites for a National Wildlife Refuge; sites that supported the greatest number of natural communities were considered in an Environmental Impact Study (Clark and Slusher 2000). Based on gap data, the boundary of a new national park site in Idaho was enlarged by a few hectares to include additional plant communities (Wright et al. 1994). In Ohio, a comparison of pre-settlement conditions and current extent of plant communities was used to prioritize under-represented communities for inclusion in regional nature reserves (Stritthold and Boerner 1995). In each of these cases, additional information (i.e., models, ground-truthing) was included in the final conservation decisions, but the gap data were the starting point.

The Bay Area Gap Analysis could be used in a similar manner by regional organizations, with the understanding that ground-truthing and additional data will be necessary. Information from this report can be used to select a suite of priority communities for management plans, and as a first step in the selection of potential acquisitions for reserve locations.

San Francisco Bay Area Conservancy Program

The California State Coastal Conservancy's San Francisco Bay Area Conservancy Program (Bay Program) was established by the Legislature in 1997. Through the Bay Program the Conservancy has undertaken over 100 projects to date in the nine counties surrounding San Francisco Bay, working with more than 60 government agencies and local conservation organizations to achieve the following goals:

- Improve public access to and around the bay, coast, ridge tops, and urban open spaces through the completion and operation of regional trails (particularly the San Francisco Bay Trail, Bay Area Ridge Trail, and California Coastal Trail), local trails that link population centers and public facilities to regional trail systems, and related facilities such as interpretive centers, picnic areas, staging areas, and campgrounds.
- Protect, restore, and enhance natural habitats and connecting corridors, watersheds, scenic areas, and other open-space resources.
- Promote, assist, and enhance projects to provide open space and natural areas that are accessible to urban populations for recreational and educational purposes.

The activities of the San Francisco Bay Area Conservancy Program are guided by long-term natural resource and recreational goals identified in collaboration with cities, counties, regional government bodies including the Bay Conservation and Development Commission and Association of Bay Area Governments, nonprofit conservation organizations including the Bay Area Open Space Council and San Francisco Bay Joint Venture, and other interested parties.

In it first four years, the San Francisco Bay Area Conservancy Program, in collaboration with its partners, has completed or undertaken the following:

- Acquisition of nearly 9,000 acres of wildlife habitat and open space, including wetlands, redwood forests, grasslands, coastal scrub, and oak woodlands. Most acquisitions have expanded lands accessible to the public and preserved habitat for endangered species.
- Preservation of over 16,000 acres of agricultural land through the purchase of conservation easements.
- Development of 16 trails or access ways and support of the San Francisco Bay Trail and the Ridge Trail Programs.
- Ecological improvements for five Bay Area wetlands and fourteen creeks.
- Development of fifteen public access facilities and programs, including visitor centers, parks, piers, and environmental education programs.
- Numerous resource plans for wildlife habitat, open space, and public access.

1.1 Organization and Content of this Report

This report includes four main sections: introduction, methods, results, and discussion of the gap analysis of the San Francisco Bay Area. Following the report are literature cited, endnotes, a glossary, and ten appendices, including profiles and maps of natural communities, and a summary of the California State Gap Analysis. Section 1 of the report, the introduction, describes the project purpose and provides background on the non-technical aspects of gap analysis. Section 2 describes the methodology used to conduct the analysis. Section 3 describes the results of the regional gap analysis of the Bay Area. Section 4 discusses the results of the Bay Area analysis, along with implications for Bay Area conservation and possible next steps.

1.2 An Overview of Gap Analysis Methods

How does gap analysis determine which communities are inadequately protected? The primary tool of gap analysis is the Geographic Information System (GIS), a computer application that displays and manipulates digital maps of various types of data. A GIS allows several map layers, each representing different data, to be overlaid and manipulated for visualization and analysis. For a gap analysis, three layers of spatial data are usually obtained or developed (Figure 1).

The *Land Cover* layer displays the distribution of natural plant communities (such as chaparral, grasslands, forest), non-natural plant communities (typically agriculture) or other types of land cover (rock, sand, water, urban, etc.).

A *Wildlife* layer depicts the distribution of habitats for terrestrial vertebrate species. Habitats are interpreted from the land cover layer and knowledge of the relationships between wildlife and plant community composition and structure. Maps are then based on a series of probability distributions. The use of vegetation to predict wildlife locations is complex and remains an evolving science (Short and Hestbeck 1995; Jennings 2000). The San Francisco Bay Area Gap Analysis focuses on distributions of natural communities and does not include the development of a wildlife layer.

The *Stewardship* layer portrays the degree of protection for natural communities in an area. Creating the stewardship layer is a two-step process. The first step is identifying the ownership of all land: private, or owned by local, state or federal agencies. Second, each ownership unit is classified into four "status levels" based on the type of management, with status 1 representing the highest level of protection. The underlying principle for this classification process is that the level of long-term biodiversity protection can be inferred from the type of management.

Once the stewardship layer has been classified and the other data layers completed, the GIS is used to digitally superimpose the stewardship layer on the land cover layer or wildlife layer. The software can then calculate how much of each land cover type or wildlife habitat type falls within various protected areas. This step is referred to as the "representation analysis" because it identifies how well various elements are represented

within protected areas. The results are summarized by tabulating the area and percent of total mapped distribution of each element in different land stewardship and management categories.

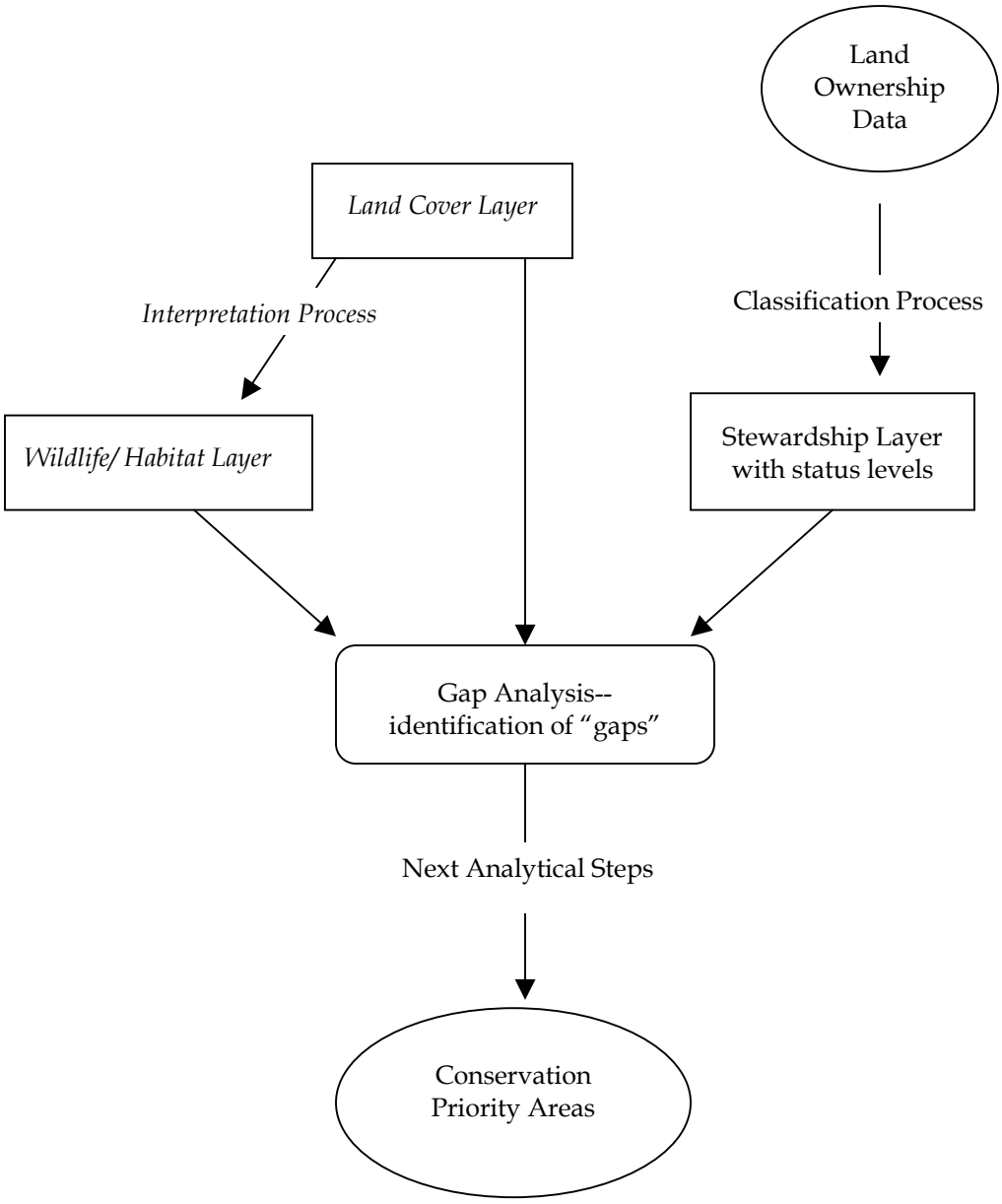

Figure 1. Flow Chart of the Gap Analysis Process. Modified from California Gap Analysis Project. 1998. Italic type indicates wildlife analysis steps not conducted in the San Francisco Bay Area gap analysis.

These results are then compared to a target level of adequate protection to identify gaps. For example, a state or country may have set a goal of protecting 15% of the area of all natural communities within national parks or other protected status areas. In this case,

15% represents "protected well enough." Gap analysis would compare the actual protected area for each community against a 15% benchmark to determine which species or communities already meet or exceed the 15% level, and which do not.

1.3 History and Applications of Gap Analysis

Gap analysis seeks to identify species or natural communities "that are not adequately represented in the current network of special management areas" (Scott et al. 1993; USGS Gap Analysis Program 2000). Those communities or species that have little or no presence in existing special management areas, such as parks, nature reserves, or ecological study areas, for example, constitute protection "gaps." These elements are considered conservation priorities, and all other elements that are well represented in existing protected areas are non-priorities.

Gap analysis was developed in the late 1980s and entered the mainstream of conservation biology with the publication of the paper *Gap Analysis: a geographic approach to the protection of biological diversity* (Scott et. al 1993). The gap analysis concept subsequently evolved into a national program coordinated by the Biological Resources Division of the U.S. Geological Survey (http://www.gap.uidaho.edu/). Each state is conducting or has already completed its own statewide analysis. According to the National Gap Analysis Program, thirty-nine states had completed assessments as of 2001. The state programs seek to utilize consistent minimum standards and consistent definitions such as the stewardship classifications, described below, so that results may be compared from state to state. The national program continues to refine the analytical approach through ongoing research and dissemination of the reports from each state. More recently, Gap analyses have been conducted in many other countries.

California completed a state gap analysis and final report in 1998. The complete California Gap Analysis Project report may be found at the California Gap Analysis web page at www.biogeog.ucsb.edu. A summary of the California Gap Analysis is provided in Appendix 4.

Gap analysis is a proactive approach to conservation. In part, its development was spurred by the recognition that a species-by-species approach to conservation, as exemplified by the Endangered Species Act, was inefficient (Hutto et al. 1987; Scott et al. 1987). It does not, however, replace endangered species programs that attempt to resuscitate populations on the brink of extinction; rather, it is complementary to them. The stated goal of the Endangered Species Act of 1973 is "to provide a means whereby the *ecosystems* [italics added] upon which endangered species and threatened species depend may be conserved" (P.L. 94-325, as amended). By protecting natural communities, gap analysis seeks to prevent the listing of additional threatened or endangered species that live in these communities.

The concept of protecting entire natural communities, such as through gap analysis, is considered the "coarse-filter" approach in which 85% to 90% of species would be protected (TNC 1982, Noss 1987). The complementary "fine-filter" approach, such as

the Endangered Species Act, would protect the remaining 10% to 15% of species by focusing on rare or specialized species that are not protected in reserves. Although initial gap projects focused on terrestrial vertebrates, gap analysis has always been conducted at the scale of community or landscapes and has always included mapping of vegetation. Some recent gap projects included invertebrate species and aquatic ecosystems (USGS 2000).

Gap analysis is a scoping tool for conservation planning. It identifies conservation needs in the form of protection gaps and helps conservation organizations set priorities. But gap analysis is typically a preliminary step because it does not identify the specific land units needed to fill the gaps nor does it provide methods to select these land units. Identifying areas for conservation action will occur in the follow-up steps of the planning process, and should include a host of other factors: the condition of the community, its habitat value, and which areas are large enough to maintain plant and animal populations (Anderson 1999).

1.4 Limitations of Gap Analysis

Gap analysis has been called the best available technique to identify protection gaps, but it is only a tool and is subject to certain inherent limitations. Some of these limitations are technical, while others are conceptual. Recognizing the limitations of gap analysis is necessary for appropriate application of its findings.

1.4.1 Technical Limitations

Gap analysis utilizes maps of large stands of dominant vegetation cover based on remote sensing. The data are intended to make only general statements about conservation status.

- The data do not ensure that a particular natural community occurs in a certain area, but rather the mapping accuracy indicates the probability of a community occurrence.
- Ground truthing of gap data is usually very limited due to budget constraints. For example, the land cover layer produced by the California State Gap Analysis was not formally assessed for accuracy. The layer is described as "generally in high agreement with other large-scale vegetation maps" (Davis et al. 1998) but "high agreement" is not quantified.
- Maps generated by gap analysis do not depict species composition, species diversity, community condition, habitat quality, or stand age.
- The mapped boundaries of natural communities are approximations. Community boundaries often represent gradients, which can range from gradual to sharp.

Because gap data sets are produced at a finite scale, they do not show features smaller than the minimum mapping unit.

- The variation within a natural community patch is not shown by gap data sets. The minimum mapping units employed in the land cover mapping are too large to capture some riparian corridors or communities that typically occur as inclusions in large

communities. The presence of these riparian corridors and communities may thus be underestimated throughout their distribution.
- Gap data may underestimate communities that occur in small habitat patches. Such communities will need to be further assessed via other methods.

Gap data represent a fixed point in time, but land cover and stewardship change.
- The ideal gap analysis would have up-to-the-minute data, which is logistically and financially impossible. From the moment a data set is collected, it begins to become out of date.
- Because gap data represent a snapshot, the data cannot demonstrate trends in land cover and stewardship.
- Gap data do not capture the historic loss of natural communities or habitats.

1.4.2 Conceptual Limitations

Gap analysis is not a thorough inventory of biological resources.
- Gap analysis does not consider the specific needs of individual species. Analysis results should not be applied to endangered species or critical habitats.
- Gap analysis is not a substitute for existing programs that provide research, management or protection for individual species (e.g., Endangered Species Act, state Natural Heritage Programs (Jenkins 1985)).
- Gap analysis does not consider other values and uses for preserving open space. These values or uses may be very important, but gap analysis is not the right tool to evaluate them.

Gap analysis compares existing levels of protection to target levels of protection, but adequate protection remains undefined.
- The adequate level of protection varies depending on the needs of the individual species or community under consideration. Often, the detailed knowledge required to determine adequate protection is not available (Noss 1992).
- If the original extent of a natural community has been greatly reduced by exotic species, conversion to anthropogenic use, or other causes, setting a protection goal based on a percent of its currently existing area may not make sense (Jennings 2000; Stoms 2000).

Ideally, the geographic scope of a gap analysis should be determined by the boundaries of a coherent ecosystem or ecoregion. Many gap analyses, however, are conducted by nations, states or regions whose boundaries were politically determined.
- The extent of natural communities, and the species they contain, is unrelated to political boundaries.
- Rarity of a natural community or species within a political boundary may be independent of rarity within an ecoregional boundary.
- Most conservation planning is, however, conducted by agencies within politically-defined jurisdictions (Jennings 2000).

1.5 A Regional Gap Analysis of the San Francisco Bay Area

The San Francisco Bay Area (Bay Area), is comprised of approximately 18,000 square kilometers (km^2), and includes natural communities found on the Pacific coast as well as in the Sacramento/San Joaquin delta, the Central Valley, and the coastal foothills.[1] The Bay Area contains a relatively large proportion of protected open space, in comparison to other California metropolitan areas (Davis et al. 1998). More than 150 public and private organizations are now actively working to protect open space in the region. As the Bay Area's population grows from 6.9 million toward an expected 8 million residents by 2020 (Association of Bay Area Governments 2000), development pressure will require that conservation groups maximize their efficiency in identifying and protecting the most ecologically valuable lands. With the pressures posed by development and rising land costs, completing resource protection in the Bay Area will require an organized and systematic approach. Conservation priorities can be effectively made at the regional level, and Bay Area conservation groups have a history of working together on open space protection decisions. The Bay Area Gap Analysis provides information that can help Bay Area conservation groups set joint priorities and be more cost effective (Austin 1991).

Several available data sets contributed to the decision to conduct a regional gap analysis. The San Francisco Bay Area Gap Analysis utilized land cover data developed by the California Gap Analysis Project to provide insights into resource protection that are specific to the region. An important component of the Bay Area Gap Analysis was an open-space stewardship layer that was more detailed and up-to-date than the state stewardship layer. This GIS layer of publicly owned lands was developed by GreenInfo Network, a public interest mapping organization based in San Francisco, in collaboration with the Bay Area Open Space Council staff and member organizations in 2001.[2] Development risk data from the Greenbelt Alliance was coupled with state and regional rarity data to determine which natural communities in the region should be conservation priorities. The combination of state and regional data analyzed specifically for the Bay Area provided valuable information to inform Bay Area conservation planning.

2.0 Methods

This section describes the methods used in the San Francisco Bay Area Gap Analysis, including the land cover layer developed by the California Gap Analysis Project, the open space stewardship layer developed by the GreenInfo Network, the representation analysis, and the prioritization analysis provided by Greenbelt Alliance. The Bay Area gap analysis was conducted with ArcView 3.2 software from Environmental Systems Research Institute.

2.1 Land Cover

For the San Francisco Bay Gap Analysis, the land cover layer from the California Gap Analysis Project was modified by clipping it to the outline of the nine Bay Area counties. The total amount of each natural community within the Bay Area was then calculated by summing the area occupied by each community.[3] A summary of the methods and findings from the California Gap Analysis Project, as they pertain to the regional analysis, is provided in Appendices 4, 5, and 6, and a more complete description of the mapping process is provided in Davis et al., 1991, 1995, 1998. The California Gap Analysis land cover layer maps 194 vegetation communities at the 1:100,000 scale. The minimum mapping unit for wetlands was 40 hectares (1 hectare = 2.47 acres) and for upland communities was 100 hectares.

The land cover layer from the California Gap Analysis Project (Figure 2) was determined to be the most appropriate data layer for the regional analysis, despite the data being more than ten years old (1990). It is reasonable to expect that some urban areas have expanded and some natural communities have been converted to agriculture or other human uses since 1990, but that most natural communities have changed relatively little in that time span. Although other vegetation layers were available, none of them were both more current than the California Gap Analysis Project data and consistent or detailed enough to encompass the whole Bay Area. For example, excellent digital land cover data has been developed for Point Reyes National Seashore and Suisun Marsh, but these and other projects use varied systems of vegetation classification that cannot be combined for the entire region. Furthermore, the California Department of Forestry developed a statewide land cover layer with superior spatial resolution but only included about 60 land cover types (compared to 194 mapped by the California Gap Analysis program). Many unique vegetation communities are combined into general categories (e.g., coastal scrub) under the forestry classification. The California Gap Analysis Project data are best suited to the project goal of evaluating the protection status of the range of natural communities found in the Bay Area.

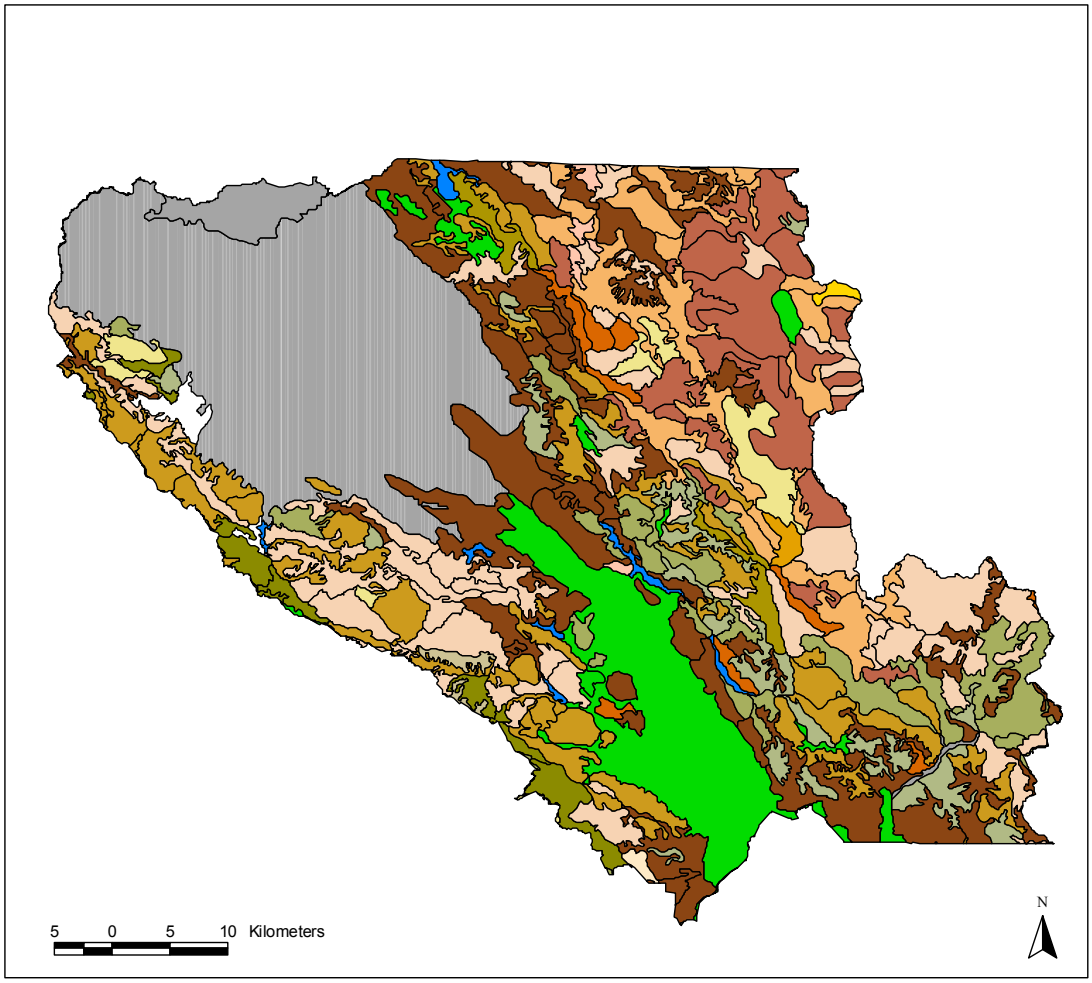

Figure 2. A portion of the Land Cover layer developed by California Gap Analysis Project showing Santa

2.2 Stewardship

The regional analysis did not use the statewide stewardship layer developed by the California Gap Analysis Project. Instead, the Bay Area analysis used a GIS layer of regional publicly owned lands developed by GreenInfo Network.[4] In this report, this layer is referred to as the "open space stewardship" layer to distinguish it from the stewardship layer developed by the state project. The open space stewardship layer offered the advantages of being more current and more detailed than the statewide stewardship layer (Figures 3 and 4). It had no minimum mapping unit, and included conservation and agricultural easements held by local land trusts.

Ownership polygons were classified into four protection status levels according to standardized definitions developed by the national gap analysis program, and used in the state gap analysis. Specifically, the management characteristics used to assign status codes are:

- Permanence of protection from conversion of natural land cover to unnatural (human induced barren, exotic dominated, arrested succession).
- Relative amount of the tract managed for natural cover.
- Inclusiveness of the management (single feature or species versus all biota).
- Type of management and degree that it is mandated through legal and institutional arrangements.

The four levels describe the relative degree of long-term management focus on biodiversity conservation as indicated by legislation or expressed in other written policies. The protection status levels are defined as follows (Davis et al 1998):

> Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency and intensity) are allowed to proceed without interference or are mimicked through management.
>
> Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use of management practices that degrade the quality of existing natural communities.
>
> Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area.
>
> Status 4: Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types (arrested succession, dominance by exotics) and allow for intensive use throughout the tract, or existence of such restriction is unknown.[5]

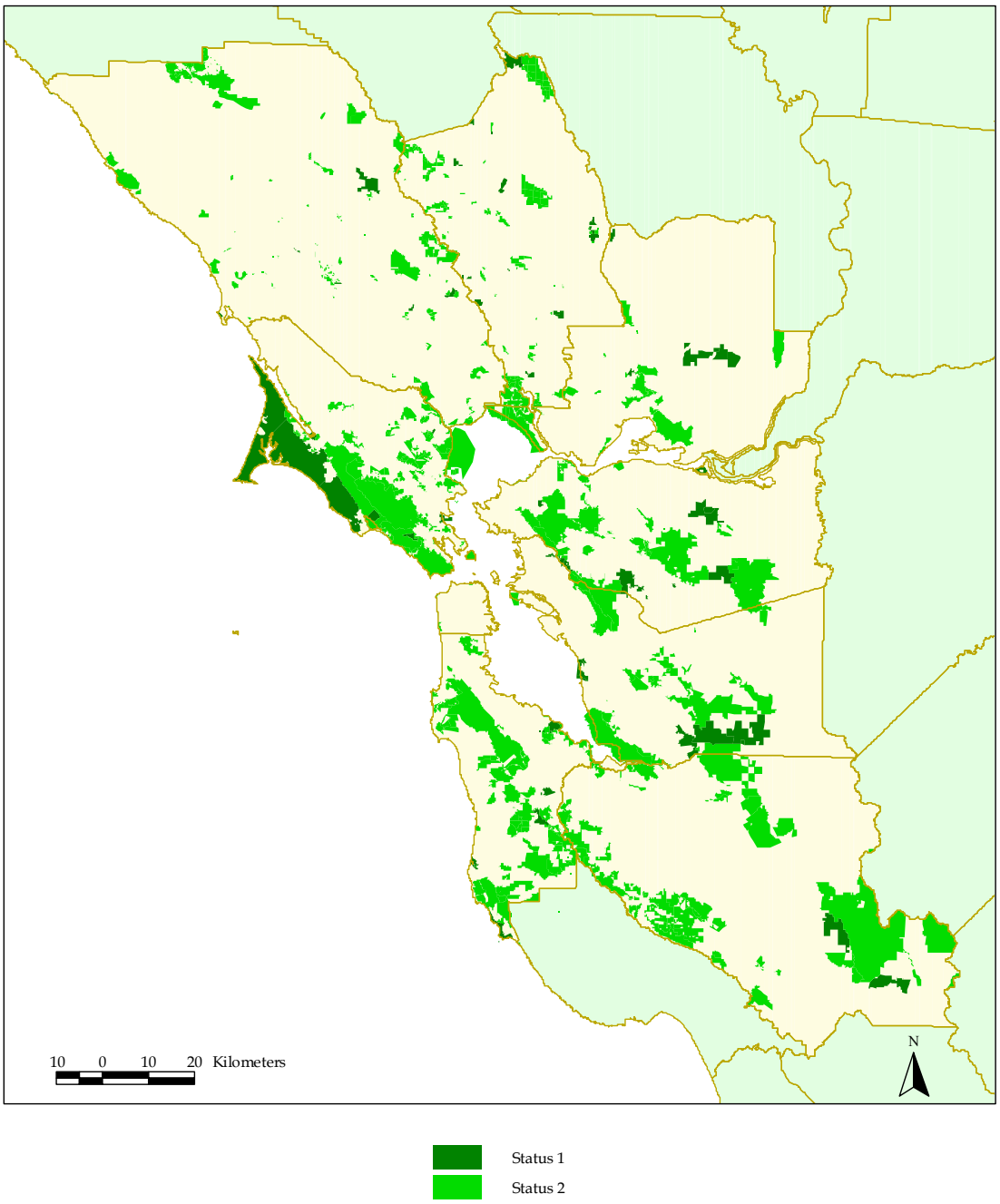

Figure 3. Status 1 and Status 2 Lands in the Bay Area based on the Bay Area Gap Analysis open space stewardship layer and additional research. Compiled by GreenInfo Network, various sources.

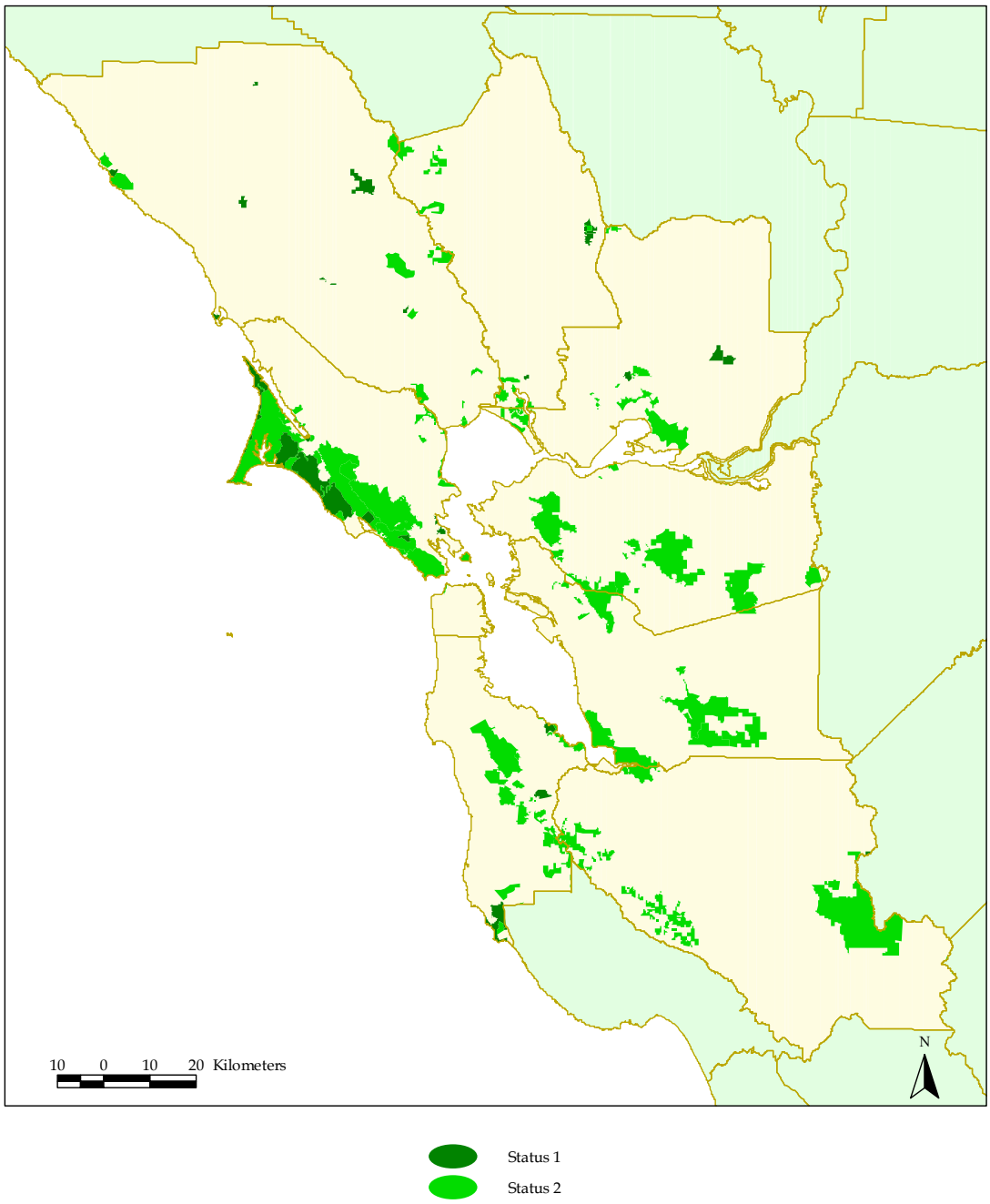

Figure 4. Status 1 and 2 Lands in the Bay Area based on the California Gap Analysis stewardship layer.

It is important to note what the stewardship status categories do *not* represent. The gap classification system reflects only the level of permanent biodiversity protection, as

determined by documentation. The classification levels cannot evaluate whether management intent is actually being carried out, or otherwise evaluate the actual land management. Many land units, either privately or publicly owned, may currently support rich biodiversity, but without permanent legal protection, the status of these lands could change at any time.

From a practical perspective, the most significant break in the stewardship classification occurs between Status 2 and Status 3 lands. Status 1 and 2 lands are lands on which the cardinal management mandate is biodiversity conservation and protection is permanent or very long-term and ensured by legal or institutional mandate. These two categories differ only in the extent to which natural processes such as fire, flooding, or disease are allowed to proceed or mimicked through management. Status 3 and 4 lands, however, are managed primarily for other purposes such as intensive recreation, extractive use or flood control. Throughout much of the results and discussion, Status 1-2 lands and Status 3-4 lands are combined, respectively. For the purposed of this gap analysis, Status 1 and 2 lands are considered to be protected open space.

To accomplish the classification for the regional gap analysis, the open space stewardship layer was sorted according to the name of the owner of each polygon (e.g. Department of Fish and Game, Bureau of Land Management), resulting in a set of land units held by each owner. Then information was sought on these holdings from the owners' web pages, printed materials such as master plans, other maps, and conversations with organizational staff. The information obtained from these sources was used to identify the status of land units as well as the existence of new holdings. Where appropriate, staff members were also asked to provide GIS data (ArcView shape files) to add new acquisitions or modify polygon boundaries.

It was necessary to classify each of the ownership polygons in the open space stewardship layer with the decision rules used by the California Gap Analysis Project to make valid comparisons between the regional and state results (Appendix 2). The status assignments were generally a good fit when applied to lands held by the U.S. government and the state of California. However, it quickly became clear that the status assignments were an oversimplification for other owners and that an overly simplified classification would not result in the quality of analysis desired. Many holdings were researched in detail to better identify their status, particularly if the land unit under consideration was large. Based on the information obtained, the status assignment rules in Appendices 2 and 4 were excepted whenever additional information about a property indicated that a different classification more accurately reflected actual management intent.

For example, the status rules employed by the state project would have classified all of the lands held by the East Bay Regional Park District as Status 3 under the "county and regional parks" category. Instead, information in EBRPD's Master Plan, on the District's web site, and gathered at a meeting with District staff was used to classify the District's holdings. The result was thirty-five Status 1 properties, seventy-four Status 2 properties, thirty-nine Status 3 properties, and eighteen Status 4 properties.

Additional classification guidelines were also developed for some unique types of holdings found in the open space stewardship layer classification.

- Most "urban" parks (defined here as parks owned by cities), fairgrounds, cemeteries, public golf courses, schools, and similar lands were classified Status 4. Parks with acreage of 200+ acres, or with names that incorporated the terms "open space," "wildlife area" or other terms that indicated potential exceptions to this guideline, were investigated further and classified based on the additional information.
- Most agricultural lands, including lands with easements in place to ensure continued use as agriculture, were classified as Status 4. A few polygons were classified Status 3 based on available information that justified this classification. Status 4 is appropriate for orchards, vineyards, row crops, hay, and most livestock operations. Some cattle ranching operations with low intensity grazing would qualify as Status 3. However, it was impractical to review the individual easements on the large number of these properties and obtain sufficient information to justify a lower classification.
- Lands of "undesignated" status owned by Department of Fish and Game, local park districts, or others that lacked sufficient information were generally classified as Status 3.
- In many cases it was impossible to determine whether the use currently existing on a property exceeded the 5% portion of the Gap decision rules B-1, B-2 and B-3 in Appendix 2. In some cases, land managers were asked to estimate the percent of land in use. In other cases, subjective classification decisions were made based on the overall intent of management of the organization or agency.
- The distinction between Status 1 and Status 2 lands was extremely difficult to make since the distinction was principally based on whether management allowed or mimicked natural processes and this information is not readily available. Most open space district lands and lands owned in fee by land trusts were classified Status 2, rather than Status 1. That decision was based on the assumption that allowing or mimicking natural processes such as fire and flooding would be difficult, expensive or require specially trained personnel, and therefore unlikely to occur. The distinction between Status 1 and 2 is not significant since these categories are combined in virtually every step of the analysis.
- Every effort was made to apply the classification rules consistently and objectively; however, classification is an inherently subjective process. Upon completion of the classification process, regional total area for each category was calculated.

2.3 Representation Analysis

The representation analysis determines the extent to which natural communities are represented by, or protected in, the existing open space reserve system. The land cover layer and stewardship layer were superimposed to identify and tabulate the extent of each natural community within each protection level, including all areas mapped as primary, secondary, and tertiary vegetation.[6] The extent of each natural community within Status 1 and Status 2 (the levels considered protected) was tabulated for the region. The summed area of each natural community within these protection levels was then compared to their total regional extent and converted to a percentage in protected status.

The results of the previous steps were compared to two threshold levels to assess adequate representation. First, the natural communities in the Bay Area that have documented declines in excess of 80% were selected for comparison against a threshold of 100% protection of remaining lands. Second, all of the remaining natural communities were evaluated against a target level of 20% protection. A target level of 20% allows for comparison with the California Gap Analysis Project, because 20% was the middle target value utilized by the state project. Those natural communities that did not meet their target percentage (100% or 20%, depending on their current mapped extent) were identified as gaps.

The subset of natural communities selected for comparison at the higher target percentage was based on the degree of loss of historical extent as documented in the USGS report *Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation* (Noss et al. 1995). Through an extensive review of literature documenting the declines of individual ecological communities,[7] the report authors determined that among northern California communities, native grasslands, coastal bunchgrass communities, coastal redwoods, riparian woodlands, and inland and coastal wetlands including vernal pools, had all experienced 80% or greater losses (Table 1).

Table 1. Estimated Losses of Historic Extents of California's Natural Communities. Adapted from Noss et al., 1995. Endangered Ecosystems of the United States.

Natural Community	Estimated Loss of Historic Extent
Native Grasslands	99%
Northern Coastal Bunchgrass Communities	90%
Coastal Redwood Forests	85%
Central Valley Riparian Forests	89%
Central Valley Vernal Pools	88%
Inland Wetlands	94%
Coastal Wetlands	80%

Based on this work, the following 8 communities (following Holland 1986) were compared against the 100% threshold:

- Coastal Prairie
- Valley Needlegrass Grassland
- Northern Claypan Vernal Pool
- Alluvial Redwood Forest
- Great Valley Cottonwood Riparian Forest
- Northern Coastal Salt Marsh
- Coastal Brackish Marsh
- Coastal and Valley Freshwater Marsh

Communities in this subset that did not meet the desired representation level were designated as gaps.

2.4 Prioritization

Prioritization is critical to the allocation of limited resources in the face of ongoing loss and degradation of native vegetation (Pressey 2001). Although not part of the gap analysis protocol required by the National Gap Analysis Program, prioritization was used in the California Gap Analysis and may be helpful for Bay Area conservation planning.[8]

The prioritization process in this project was based on four factors: 1) community endemicity in the Bay Area, 2) local threat level posed by development, 3) a combined statewide threat level and statewide rarity ranking, and 4) level of statewide protection. Each community was ranked for the four factors; the rankings were then summed in a simple scoring approach. The prioritization analysis was performed only on the communities identified as under-represented in the results of the representation analysis.

Bay Area Endemicity*:* The proportion of each community that exists in the Bay Area relative to the state was calculated. The results of this intermediate step were then used to assign an endemicity score from 1 to 3. The endemicity score reflects the Bay Area's relative conservation responsibility. For example, with 99% of the statewide distribution of Northern Claypan Vernal Pool found in the Bay Area, effective conservation of this community can only occur locally.

Under this factor, communities were assigned points based on the following:

> 1 point: Communities with less than 10% of statewide extent found in the Bay Area.
>
> 2 points: Communities with between 10 and 30% of statewide extent found in the Bay Area.
>
> 3 points: Communities with greater than 30% of statewide extent found in Bay Area.

***Local Development Risk**:* An existing map of development risk, available as a GIS layer from Greenbelt Alliance, a local nonprofit organization, was used to pinpoint communities with the highest regional potential to be lost through conversion to human use.[9] This risk assessment layer (Figure 5) was compiled by Greenbelt Alliance in 1999 and identifies areas at high, medium or low pressure for development as well as existing urbanized areas. Development risk indicates the *probability* that development will occur at a site over time. Risk levels were modeled on the likely direction of urban, suburban or "ranchette" development based on existing city and county zoning plans, land use regulations, topography and other factors. High risk lands are defined as those under significant pressure for development within the decade from 1999 to 2009, while medium risk lands are under pressure for development in the next 10-30 years and low risk lands are those not expected to experience development pressure in the next 30 years. A description of the techniques used by Greenbelt Alliance in the assessment process is included in Appendix 9.

To evaluate the risk level of each under-represented natural community, the risk layer was intersected with the land cover layer.[10] This step provided the area of each natural community polygon that fell into areas designated as high or medium risk. The total at-risk area was then tabulated for all primary, secondary and tertiary occurrences of the community. Finally, the summed area within the two risk levels was compared to the total regional extent of each natural community and converted to a percentage at risk.

Under the local development risk factor, communities were assigned points based on the following:

> 1 point: Less than 10% of the community's Bay Area extent is within the high or medium risk levels.
>
> 2 points: Between 10 and 20% of the community's Bay Area extent is within the high or medium risk levels.
>
> 3 points: More than 20% of the community's Bay Area extent is within the high or medium risk levels.

***Statewide Risk and Rarity**:* The third prioritizing factor was based on a system of statewide rankings from the California Department of Fish and Game Natural Heritage Division (NHD). The first digit of the NHD ranking is a measure of distribution extent (rarity) and the digit following the decimal point is a measure of threat. Thus the first number rates the community from rare to common and the second rates it from threatened to secure. In cases where the status of the community varies widely throughout the state, a range of threat may be reported. Definitions of the NHD rankings are provided in Table 2.

The NHD rankings do not provide the detailed local information found in the Greenbelt Alliance data. However, they offer two other useful insights: 1) the rankings evaluate the status of each community over a broader range (although status outside the state boundaries is not included); and 2) the threat portion of the ranking is not limited to

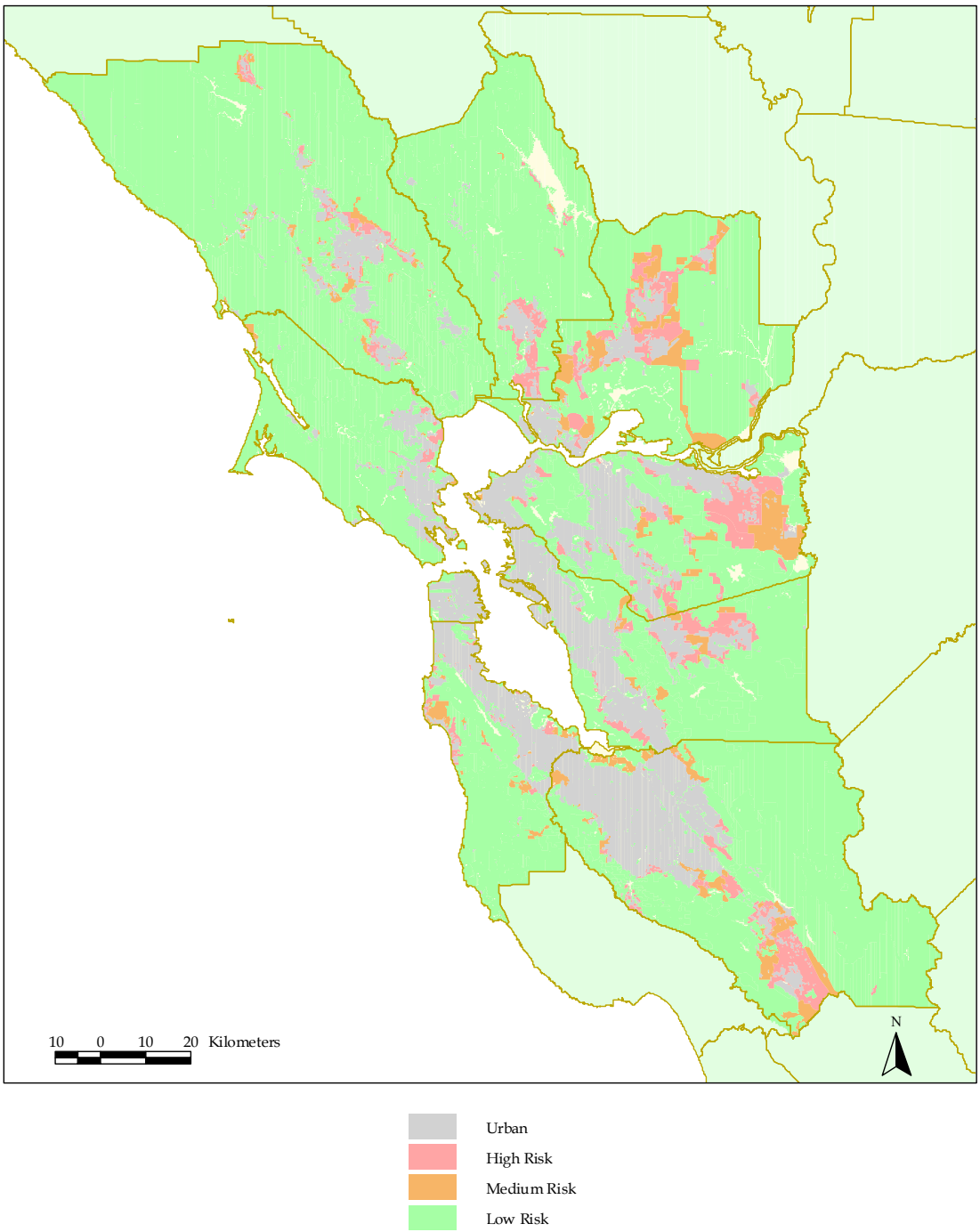

Figure 5. Development Risk Level in the Bay Area. Source: Greenbelt Alliance, 1999. Parks and other

development pressure. Instead, it attempts to summarize all types of threat including altered disturbance regimes, and invasive species.

Table 2. California Department of Fish and Game, Natural Heritage Division State Ranking Codes.

Rank	Subrank	Description
S1		Less than 6 community occurrences or less than 1000 individual or less than 2000 acres statewide.
	S1.1	Very threatened
	S1.2	Threatened
	S1.3	No current known threats
S2		6-20 community occurrences or 1000-3000 individuals or 2000-10,000 acres statewide.
	S2.1	Very threatened
	S2.2	Threatened
	S.2.3	No current known threats
S3		21-100 community occurrences, or 3000-10,000 individuals or 10,000-50,000 acres statewide.
	S3.1	Very threatened
	S3.2	Threatened
	S3.3	No current known threats
S4		Apparently secure within California This rank is clearly lower than S3 but factors exist to cause some concern, i.e. there is some threat or somewhat narrow habitat. No threat ranks are associated with this category
S5		Demonstrably secure to ineradicable within California. No threat ranks are associated with this category.

Under this factor, communities were assigned points separately on rarity and threat. Possible total combined points could range from 0 to 4.

Rarity	2 points: the community is rated S1 (very rare)
	1 point: the community is rated S2 (rare)
	0 points: the community is rated S3, S4.
Threat	2 points: the community is rated SX.1 (very threatened)
	1 point: the community is rated SX.2 (threatened)
	0 points: the community is rate SX.3 (no current known threats)

Statewide Protection Level: The last scoring factor was the level of statewide protection. This score uses the results of the representation analysis completed by the California Gap Analysis Project and reported in Appendix 6. This factor adjusts the prioritization for communities that are under-represented in the Bay Area, but adequately represented

elsewhere in the state. These communities will be ranked lower than communities that are under-represented throughout both regions.

For communities in the group targeted for 20% representation in the Bay Area:

1 point: the community has less than 20% but more than 10% of its extent protected statewide.

2 points: the community has less than 10% of its extent protected statewide.

-2 points: the community has greater than 20% of its extent protected statewide.

For communities in the group targeted for 100% representation in the Bay Area:

1 point: the community has less than 100% but more than 50% of its extent protected statewide.

2 points: the community has less than 50% of its extent protected statewide.

The final score for each community was determined by summing all points assigned via the four factors. The prioritization scores are based on the above classification scheme and could be altered by weighting categories differently.

3.0 Results

The land cover and open-space stewardship layers were employed in the representation analysis to determine which communities are conservation gaps (i.e., are not protected at target levels). Next, the prioritization analysis demonstrated which communities are considered rare or at risk of development, and are thus in greatest need of protection.

3.1 Land Cover

Within the Bay Area, the total area of mapped land cover, both natural communities and other land cover types, is 18,206 km^2 and constitutes slightly less than 5% of the state. Of the 194 natural communities and 27 non-natural land cover types mapped by the California Gap Analysis Project, 64 natural communities and 17 land cover types occur in the Bay Area. Appendix 7 contains the complete list of natural communities and non-natural land cover types found in the Bay Area and the area of their mapped distributions. The most common and the least common of these communities are discussed to provide an overview of Bay Area land cover. For this report, the most common communities are defined as those communities with an area greater than 400 km^2 (approximately 2% of the total Bay Area), and the least common communities are those with an area less than 4 km^2 (approximately 0.02% of the total Bay Area).

3.1.1 Most Common Natural Communities

Eight natural communities and three non-natural land cover types exceeded 400 km^2, or 2.0% of the Bay Area (Table 3). Figure 6 shows the distribution of urban and agricultural land covers in the Bay Area. Figure 7 shows the distribution of the most common natural communities in the Bay Area. Analysis of the most common natural communities and land cover in the Bay Area included several findings:

- Approximately 19% of the Bay Area was fully developed as urban areas, based on the 1990 imagery used in the mapping process. If the region were remapped today, the urbanized area would probably exceed this amount.

- Approximately 11% of the Bay Area was developed for agricultural use as of 1990. The proportional land use changes that have occurred since then are more complex than in urbanization. Some agricultural lands have been converted to housing or other uses, while other lands have been newly converted to agricultural use, typically, vineyards.

- The three non-natural land cover types, Urban and Built-up Lands, Miscellaneous Agricultural Lands, and Row and Field Crops, cover a combined total of approximately 30% of the Bay Area.

- The most widespread natural community, Non-native Grasslands at 12%, exhibits greater dominance of the Bay Area landscape than does any community across the state as a whole.

- Three of the Bay Area's most common natural communities – Non-native Grasslands, Blue Oak Woodlands and Foothill Pine-Oak woodlands – are also among the eight most common natural communities statewide.

Table 3. Most Common Natural Communities and Non-Natural Land Cover Types in the Bay Area.

Land Cover or Natural Community Name	Bay Area Extent (km^2)	Percent of Total Mapped Bay Area	State Extent (km^2)
Urban or Built-up Lands*	3,544.82	19%	18,352.5
Non-native Grasslands	2,272.53	12%	27,483.4
Mixed Evergreen Forest	1,471.08	8%	4,646.5
Miscellaneous Agricultural Lands*	1,405.40	8%	Not available
Coast Live Oak Forest	883.40	5%	2193.7
Upland Redwood Forest	786.01	4%	5407.6
Foothill Pine-Oak Woodland	735.23	4%	10,180.5
Coastal Prairie	696.38	4%	880.3
Blue Oak Woodland	628.31	3%	10,451.8
Row and Field Crops*	604.76	3%	Not available
Northern (Franciscan) Coastal Scrub	438.96	2%	469

* land cover types

3.1.2 Least Common Natural Communities of the Bay Area

Sixteen natural communities have an area less than 4 km^2, or 0.02% of the Bay Area (Table 4). Figure 8 shows the distribution of the least common natural communities in the Bay Area. Two of these natural communities were eliminated from further consideration in the regional analysis: 1) Tamarisk Scrub consists of an invasive, exotic species that is not suitable for conservation, and 2) the presence of Central Coast Cottonwood-Sycamore Riparian Forest in the Bay Area is uncertain.[11] Analysis of the least common natural communities in the Bay Area included several findings:

- Each of these natural communities occupies much less than 1% of the Bay Area.
- In some cases, a community is also rare (or less common) statewide. For example, Valley Needlegrass Grassland, California Bay Forest, Northern Claypan Vernal Pool, and Mendocino Pygmy Cypress Forest (Appendix 5).
- In other cases a community is rare only in the Bay Area because the region lies on the fringe of the community's natural range. The Northern Claypan Vernal Pool community, for example, has 99% of its mapped distribution in the Bay Area. Vernal pools often occur in patches smaller than the minimum mapping unit of the California Gap land cover layer.
- The Valley Needlegrass Grassland and California Bay Forest communities have 47% and 23% of their respective distributions with the Bay Area.

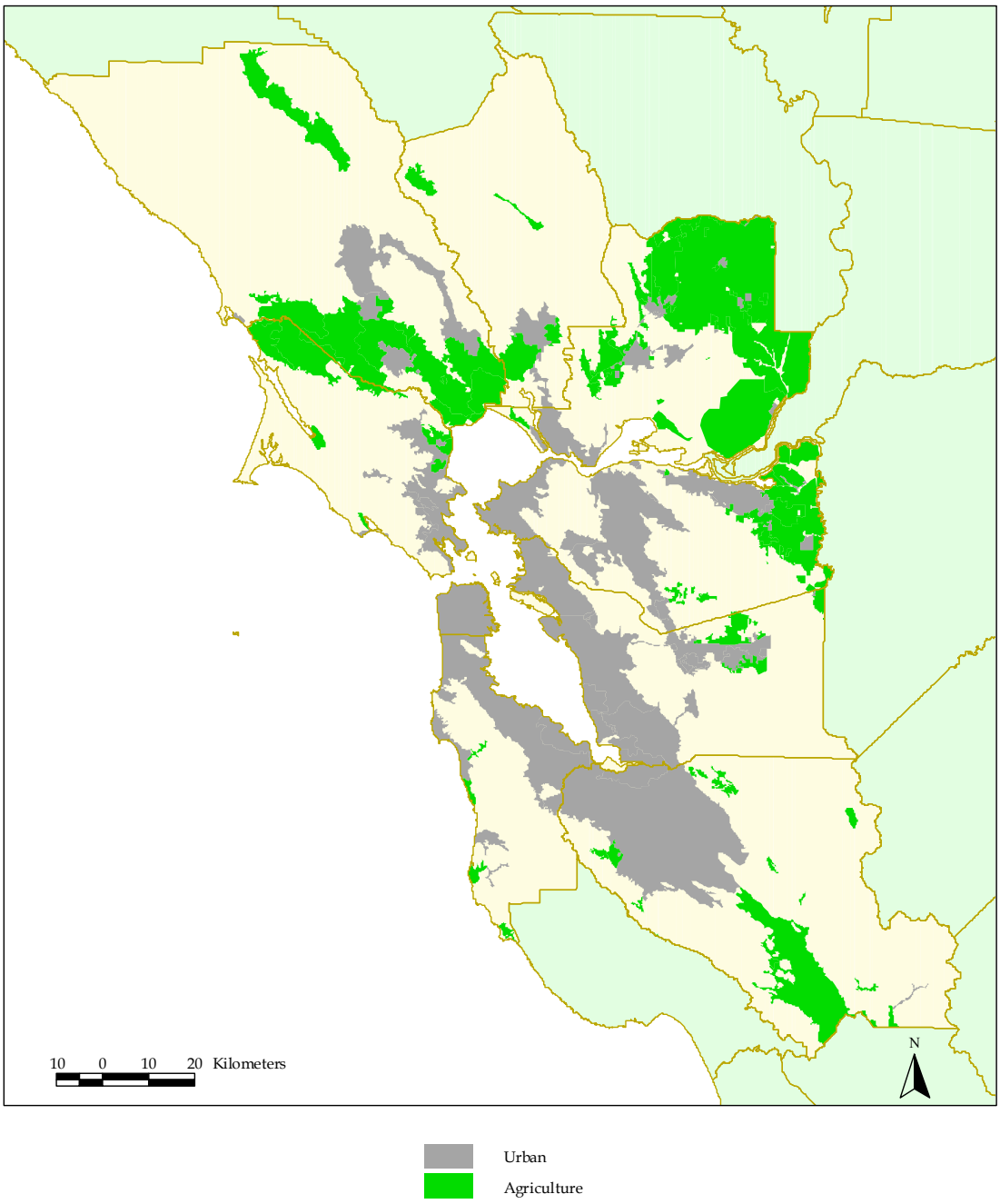

Figure 6. Most Common Bay Area Land Cover Types. Source: California Gap Analysis Project.

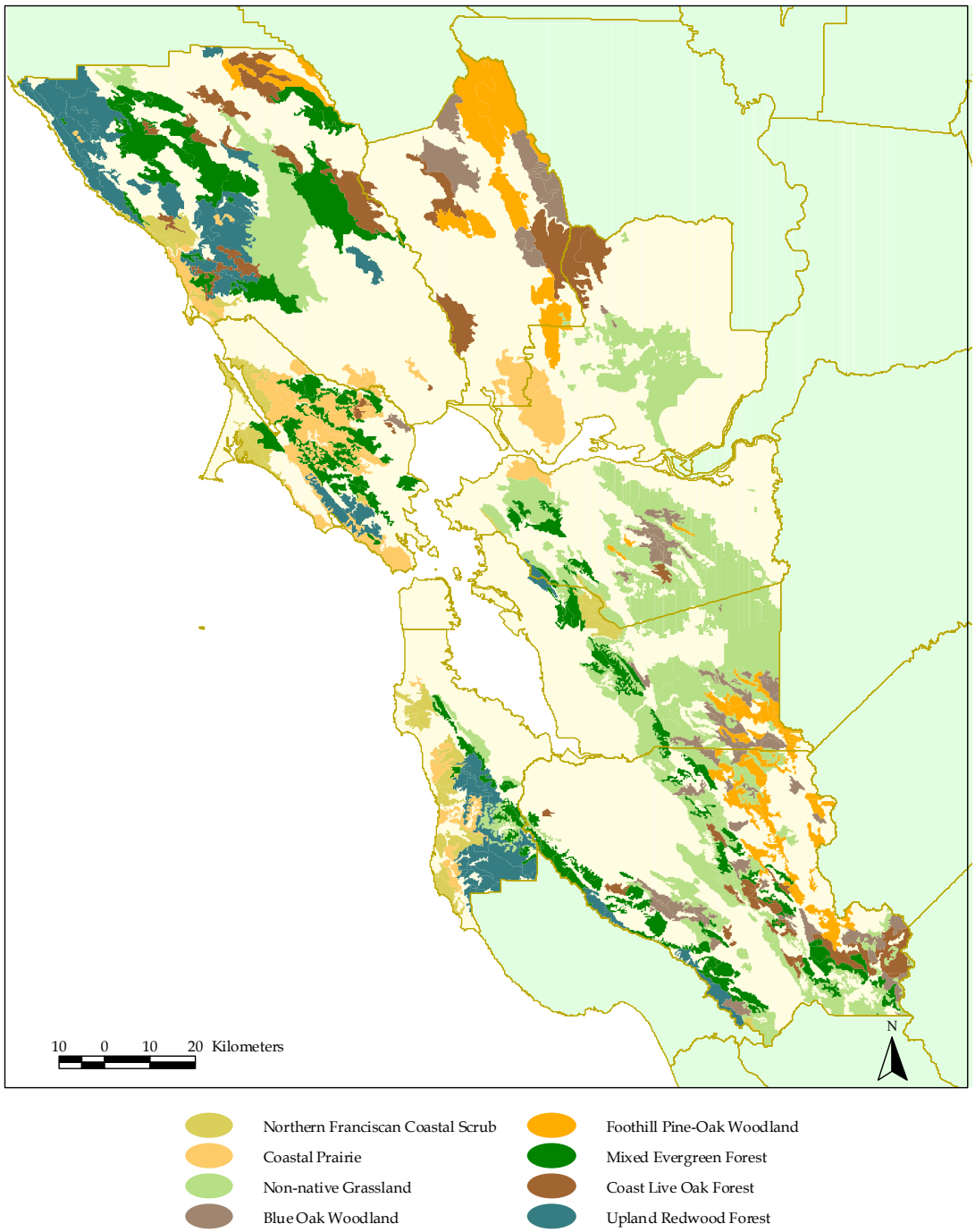

Figure 7. Most Common Bay Area Natural Communities. Source: California Gap Analysis Project.

Table 4. Least Common Natural Communities in the Bay Area.

Community Name	Bay Area Extent (km^2)	State Extent (km^2)	Bay Area % of State Extent
Central Coast Cottonwood-Sycamore Riparian Forest	0.20	77.6	0.3
Tamarisk Scrub	0.50	105.1	0.5
Mendocino Pygmy Cypress Forest	0.71	10.5	6.7
Montane Manzanita Chaparral	1.02	1329	0.1
Venturan Coastal Sage Scrub	1.03	2102.1	0.0
Semi-Desert Chaparral	1.48	2462.4	0.1
Northern Claypan Vernal Pool	1.59	1.6	99.1
Northern Interior Cypress Forest	1.89	182.9	1.0
Central Coast Arroyo Willow Riparian Forest	2.06	42.5	4.9
Montane Ceanothus Chaparral	2.14	1083.6	0.2
Mixed Montane Chaparral	2.47	1852	0.1
California Bay Forest	3.05	13.2	23.1
Monterey Pine Forest	3.17	39.2	8.1
Mixed Serpentine Chaparral	3.50	217.2	1.6
Valley Needlegrass Grassland	3.51	7.4	47.4
Great Valley Cottonwood Riparian Forest	3.96	330.5	1.2

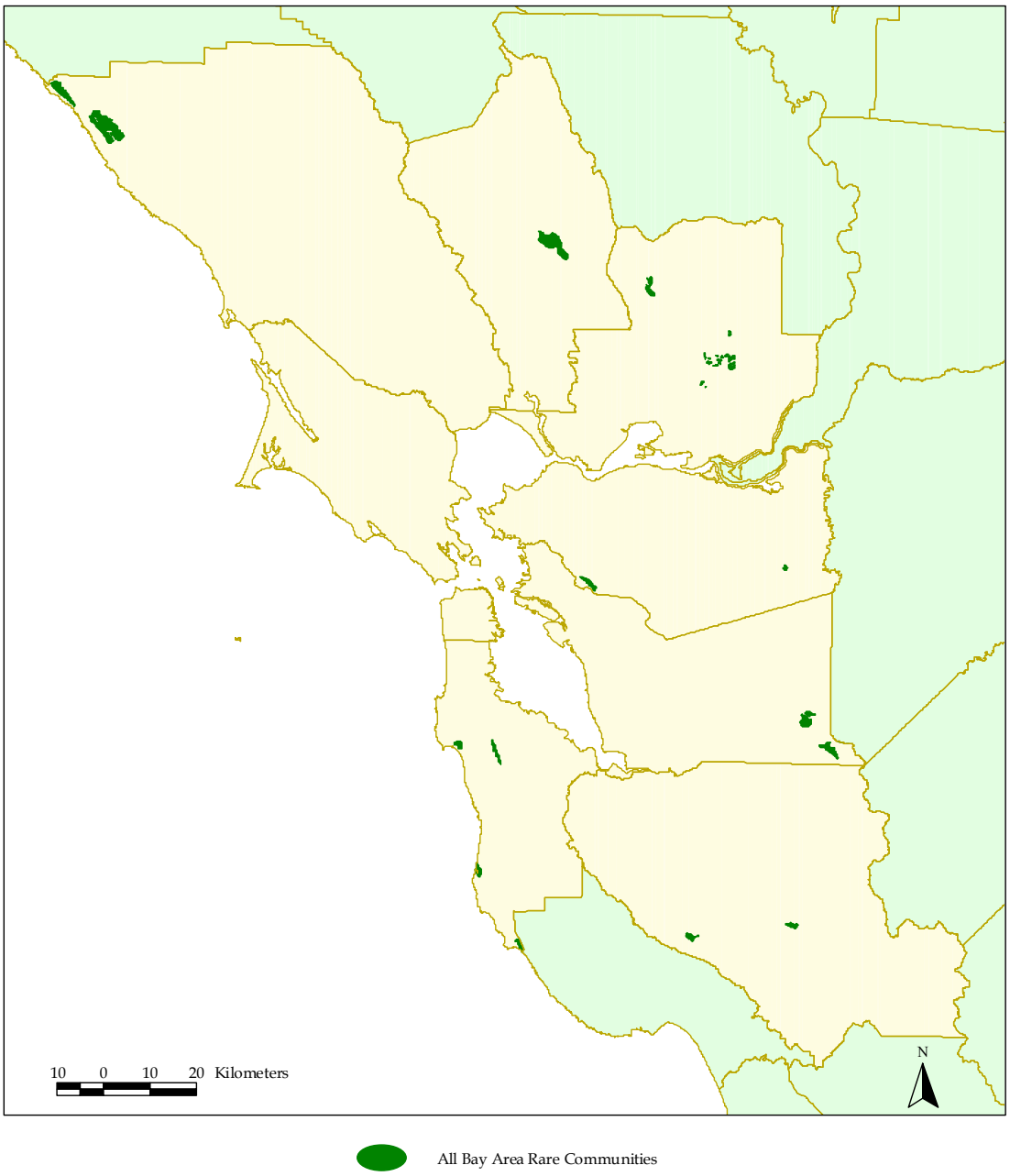

Figure 8. Least Common Bay Area Natural Communities. Source: California Gap Analysis Project.

3.2 Stewardship

The extent of Status 1, 2, and 3 lands and their respective proportions of the Bay Area are shown in Table 5. Figure 3 illustrates the distribution of Bay Area Status 1 and 2 lands (i.e., protected lands) found in the open space stewardship layer. Analysis of open space stewardship in the Bay Area included several findings:

- In the Bay Area, 16.1% of land falls into the combined Status 1 and 2 category, compared with 18% statewide.
- Status 3 lands occupy 4.2% of the Bay Area.
- Nearly 80% of the Bay Area is in Status 4, a combination of privately held lands, urban and agricultural lands, and lands managed for uses other than habitat.
- Although the extent of Status 1 and 2 land per county was not calculated, Figure 3 reveals that the counties of Marin, Alameda, Contra Costa, Santa Clara and San Mateo have a greater proportion of protected land as well as larger patches of protected land than the counties of Solano, Sonoma, and Napa. San Francisco County contains very little Status 1 and 2 land, but this is expected due to its urban nature.

Table 5. Summary of Bay Area Lands by Management Status. Source: GreenInfo Network.

Protection Status Level	Bay Area Total (km^2)	Percent of the Bay Area
1	500.9	2.8
2	2420.0	13.3
3	636.2	4.2
Combined 1 and 2 Lands	2920.9	16.1

Figures 3 and 4 illustrate the differences between the Bay Area Status 1 and 2 lands as mapped by the regional project and as mapped by the state project. The open space stewardship layer for the regional analysis includes both more polygons and more area mapped as Status 1 and 2 lands than were mapped by the state analysis for the Bay Area.

3.3 Representation Analysis

The next step of the Bay Area gap analysis consisted of determining how much of each natural community is contained, or represented by, protected Status 1 and Status 2 lands. Appendix 8 provides the complete results of this analysis. The percentage of protected lands for each of the 62 natural communities found in the Bay Area (Tamarisk Scrub and

Central Coast Cottonwood – Sycamore Riparian forest are not discussed, as per section 3.1.2) was compared against one of two levels of protection:

1) Communities with documented statewide declines exceeding 80% were compared against a 100% level of protection.

2) The remaining natural communities were compared against an arbitrarily selected 20% level of protection.

3.3.1 Target Level 100%

Eight natural communities in the Bay Area already have documented declines in excess of 80%, and were therefore selected for more stringent comparison against a 100% level of protection. The results of this comparison are shown in Table 6, and include the following findings:

- None of the eight communities met the 100% level of protection; all eight communities are thus considered conservation gaps that require additional protection.
- Two of the 8 communities have no protection whatsoever in the Bay Area: Great Valley Cottonwood Riparian Forest and Alluvial Redwood Forest.
- Two additional communities fail to meet even the 20% protection level within the Bay Area: Coastal Prairie, and Coastal Brackish Marsh.
- Three of the 8 communities are between 20% and 50% protected: Valley Needlegrass Grassland, Northern Claypan Vernal Pool, and Coastal and Valley Freshwater Marsh.
- One community, Northern Coastal Salt Marsh, is greater than 50% protected.

3.3.2 Target Level 20%

The remaining 54 natural communities were compared against a 20% level of protection. Those communities that did not meet this level of protection are shown in Table 6, and those that did are presented in Table 7. Comparison of protected natural communities against a 20% benchmark level of protection yielded the following results:

- Thirty communities did not meet the 20% level of protection and are considered conservation gaps that require additional conservation effort:
    - Eight communities have no protection whatsoever within the Bay Area.
    - Ten more communities have less than 10% representation in protected status within the Bay Area.
    - Twelve additional communities have between 10% and 20% of their Bay Area extent in protected status.

- Twenty-four communities met the 20% target representation level:
    - Sixteen communities are 20% to 50% protected.
    - Eight more communities are greater than 50% protected.

Table 6. Bay Area Protection Gaps. The eight communities with documented statewide declines in excess of 80% are shown in gray.

Community Code	Community Name (Holland 1986)	Percent of Bay Area Extent Protected	Percent Protected Statewide	Preliminary Target Representation Level
32300	Venturan Coastal Sage Scrub	8.8	8.7	20%
32600	Diablan Sage Scrub	11.6	2.4	20%
37110	Northern Mixed Chaparral	1.1	7.9	20%
37510	Mixed Montane Chaparral	0.0	26.4	20%
37530	Montane Ceanothus Chaparral	0.0	13.4	20%
37610	Mixed Serpentine Chaparral	0.0	1.0	20%
37620	Leather Oak Chaparral	0.0	18.2	20%
37810	Buck Brush Chaparral	17.9	17.5	20%
37900	Scrub Oak Chaparral	17.7	23.4	20%
41000	Coastal Prairie	17.7	10	100%
42110	Valley Needlegrass Grassland	40.9	21.7	100%
42200	Non-native Grassland	18.2	4.8	20%
44120	Northern Claypan Vernal Pool	49.9	21.3	100%
52110	Northern Coastal Salt Marsh	63.2	44.5	100%
52200	Coastal Brackish Marsh	18.7	15.7	100%
52410	Coastal and Valley Freshwater Marsh	21.1	38.5	100%
61410	Great Valley Cottonwood Riparian Forest	0.0	19	100%
63100	North Coast Riparian Scrub	0.0	3.9	20%
71130	Valley Oak Woodland	18.5	1.3	20%
71140	Blue Oak Woodland	19.5	3.8	20%
71160	Coast Live Oak Woodland	19.8	4.0	20%
71310	Open Foothill Pine Woodland	9.0	10.8	20%
71321	Serpentine Foothill Pine-Chaparral Woodland	1.5	2.8	20%
71322	Non-Serpentine Foothill Pine Woodland	7.4	8.4	20%
71410	Foothill Pine-Oak Woodland	18.3	3.2	20%
71420	Mixed North Slope Cismontane Woodland	4.1	1.7	20%

81320	Canyon Live Oak Forest	2.2	21.8	20%
81310	Coast Live Oak Forest	12.4	4.9	20%
81330	Interior Live Oak Forest	12.8	3.4	20%
81340	Black Oak Forest	6.6	7.9	20%
81400	Tan-Oak Forest	3.2	7.1	20%
82310	Alluvial Redwood Forest	0.0	4.9	100%
83130	Monterey Pine Forest	0.0	7.5	20%
83161	Mendocino Pygmy Cypress Forest	0.0	10.5	20%
83220	Northern Interior Cypress Forest	0.0	0.7	20%
84110	Coast Range Mixed Coniferous Forest	11.0	14.7	20%
84130	Coast Range Ponderosa Pine Forest	12.6	22.8	20%
84140	Coulter Pine Forest	1.3	20.5	20%

Table 7. Communities in the Bay Area that are not conservation gaps at the 20% level.

Community Code	Community Name (Holland 1986)	Percent of Bay Area Extent Protected	Percent Protected Statewide	Preliminary Target Representation Level
21320	Central Dune Scrub	33.5	27.6	20%
31100	Northern Coastal Bluff Scrub	94.9	100.0*	20%
32100	Northern (Franciscan) Coastal Scrub	38.5	23.2	20%
32200	Central (Lucian) Coastal Scrub	42.0	7.6	20%
37200	Chamise Chaparral	37.7	13.4	20%
37400	Semi-Desert Chaparral	47.0	18.5	20%
37520	Montane Manzanita Chaparral	64.1	10.8	20%
37820	Blue Brush Chaparral	23.3	13.4	20%
37A00	Interior Live Oak Chaparral	42.0	26.6	20%
37B00	Upper Sonoran Manzanita Chaparral	50.9	20.1	20%
37C20	Central Maritime Chaparral	73.6	13.5	20%
37E00	Mesic North Slope Chaparral	40.9	29.4	20%
37G00	Coastal Sage-Chaparral Scrub	55.4	5.1	20%
61220	Central Coast Live Oak Riparian Forest	63.0	15.4	20%
61230	Central Coast Arroyo Willow Riparian Forest	75.1	1.8	20%
71110	Oregon Oak Woodland	21.2	2.5	20%
71120	Black Oak Woodland	25.3	4.9	20%
71150	Interior Live Oak Woodland	23.1	4.1	20%
81100	Mixed Evergreen Forest	26.9	14.3	20%

81200	California Bay Forest	39.3	4.6	20%
82420	Upland Douglas-Fir Forest	30.1	17.6	20%
82420	Upland Redwood Forest	22.4	12.6	20%
83120	Bishop Pine Forest	57.4	20.5	20%
83210	Knobcone Pine Forest	23.4	3.8	20%

* The protection status of Northern Coastal Bluff Scrub is 100% statewide, but less in the Bay Area because of differences in the stewardship and open-space stewardship layers: the protection status of some polygons is lower in the regional analysis than in the state analysis.

3.4 Prioritization

The final step of the Bay Area Gap Analysis was to apply four criteria (as described in Section 2.4) to determine conservation priorities for natural communities identified as gaps in the representation analysis:

1) Degree of bay area endemicity
2) Local threat level posed by development
3) Combined statewide threat level/statewide rarity ranking
4) Level of statewide protection.

Table 8 presents the results of this analysis, including some of the intermediate analysis steps used to assign points.

Bay Area Endemicity: The first step in determining this score was to calculate the proportion of each natural community's statewide extent found within the Bay Area. The results of this intermediate step are shown in the column titled, "Bay Area Extent as % of State Extent." Values here exhibit a very wide range—from <0.1 to 99.1%. Note that five of the eight communities with large declines in extent, indicated in the table with gray shading, exhibit large numbers in this column. In the next column to the right are shown the point assignments based on the calculated proportions.

Local Development Risk: The results of the intersection of the development risk data with the land cover layer are shown in the column titled, "Proportion of Local Extent at Risk for Development (from Greenbelt Alliance data)." Values range from 0-53.7% of extent within the high and medium risk level areas. Five of the gap communities have 20% or more of their current extent under significant development pressure (Monterey Pine Forest, Coastal and Valley Freshwater Marsh, Venturan Coastal Sage Scrub, Great Valley Cottonwood Riparian Forest, Non-native Grassland). Two more communities face development pressure on 10% or more of their current extent (Coastal Prairie, Northern Coastal Salt Marsh).

Of the eight communities with documented declines in excess of 80% (those compared against a 100% level), four are at moderate or high risk of development (as defined in Section 2.4). These are Coastal Prairie, Coastal and Valley Freshwater Marsh, Northern Coastal Salt Marsh, and Great Valley Cottonwood Riparian Forest.

Two natural communities that have been targeted for 20% protection, Venturan Coastal Sage Scrub and Monterey Pine Forest, appear to be under intense development pressure. The risk values have been translated to prioritization scores in the next column to the right.

Statewide Risk and Rarity and Statewide Protection Level: No intermediate calculations are shown for these factors, since scores were assigned based on NHD rankings or the proportion of statewide protection. Scores in the combined Statewide Risk and Rarity category ranged from a high of 4 to a low of 0. Scores in the next category, Statewide Protection Level, ranged from –2 to 2.

Nine communities scored 3 or 4 in the NHD rankings, indicating that they are both rare and at risk, statewide. Three of these communities are also considered threatened statewide under the NHD ranking system.

Combined scores for the four factors are shown in the final column. These scores could potentially range from -2 to 10, with -2 representing the least urgency and 10 the greatest. The combined score was used to order the communities in the table from greatest priority to lowest.

Five communities received the highest priority scores of 9 or 10 out of 10 (Table 8):
- Coastal Prairie
- Northern Claypan Vernal Pool
- Monterey Pine Forest
- Coastal Brackish Marsh
- Coastal and Valley Freshwater Marsh

Another six communities had priority scores of 7 or 8 out of a possible 10:
- Venturan Coastal Sage Scrub
- Valley Needlegrass Grassland
- Northern Coastal Salt Marsh
- Great Valley Cottonwood Riparian Forest
- Mixed Serpentine Chaparral
- Valley Oak Woodland

Three communities received the lowest score of 0:
- Mixed Montane Chaparral
- Scrub Oak Chaparral
- Canyon Live Oak Forest

One community, Coast Range Ponderosa Pine Forest, received a mixed score due to the range of values shown under the NHD ranking. This community should be further assessed to ascertain its local status.

Table 8. Prioritization for Under-represented Bay Area Natural Communities. Grey shading indicates communities with 100% protection goal.

Community Code	Natural Community Name (Holland, 1986)	Bay Area Extent as % of State Extent	Bay Area Endemicity Score	Proportion of Local Extent At Risk for Development (from Greenbelt Alliance data)	Local Risk Development Score	Statewide Combined Risk and Rarity Score (from NHD Rankings)	Statewide Protection Level Score (from California Gap Analysis Project data)	Final Combined Score
41000	Coastal Prairie	79.1	3	13.4%	2	3	2	**10**
44120	Northern Claypan Vernal Pool	99.1	3	6.7%	1	4	2	**10**
83130	Monterey Pine Forest	8.1	1	53.7%	3	4	2	**10**
52200	Coastal Brackish Marsh	79.3	3	2.6%	1	3	2	**9**
52410	Coastal and Valley Freshwater Marsh	2.8	1	21.6%	3	3	2	**9**
32300	Venturan Coastal Sage Scrub	<0.1	1	45.5%	3	2	2	**8**
42110	Valley Needlegrass Grassland	47.4	3	7.5%	1	2	2	**8**
52110	Northern Coastal Salt Marsh	84.9	3	16.7%	2	1	2	**8**
61410	Great Valley Cottonwood Riparian Forest	1.2	1	23.5%	3	3	1	**8**
37610	Mixed Serpentine Chaparral	1.6	1	1.0%	1	3	2	**7**
71130	Valley Oak Woodland	2.6	1	0.1%	1	3	2	**7**
63100	North Coast Riparian Scrub	15.4	2	4.6%	1	1	2	**6**
71160	Coast Live Oak Woodland	34.4	3	9.3%	1	0	2	**6**
71420	Mixed North Slope Cismontane Woodland	28.5	2	2.0%	1	1	2	**6**
81310	Coast Live Oak Forest	40.3	3	5.8%	1	0	2	**6**
83161	Mendocino Pygmy Cypress Forest	6.7	1	0.0%	1	3	1	**6**
83220	Northern Interior Cypress Forest	1.0	1	0.0%	1	2	2	**6**

Community Code	Natural Community Name (Holland, 1986)	Bay Area Extent as % of State Extent	Bay Area Endemicity Score	Proportion of Local Extent At Risk for Development (from Greenbelt Alliance)	Local Risk Development Score	Statewide Combined Risk and Rarity Score (from NHD Rankings)	Statewide Protection Level Score (from California Gap Analysis Project data)	Final Combined Score
42200	Non-native Grassland	8.3	1	22.0%	3	0	2	**6**
71140	Blue Oak Woodland	6.0	1	6.5%	1	1	2	**5**
71321	Serpentine Foothill Pine-Chaparral Woodland	5.1	1	0.0%	1	1	2	**5**
71322	Non-Serpentine Foothill Pine Woodland	13.7	2	1.6%	1	0	2	**5**
32600	Diablan Sage Scrub	7.4	1	2.6%	1	0	2	**4**
37110	Northern Mixed Chaparral	1.1	1	0.0%	1	0	2	**4**
37620	Leather Oak Chaparral	5.7	1	0.0%	1	1	1	**4**
71410	Foothill Pine-Oak Woodland	7.2	1	1.4%	1	0	2	**4**
81330	Interior Live Oak Forest	4.5	1	3.3%	1	0	2	**4**
81340	Black Oak Forest	5.0	1	1.1%	1	0	2	**4**
81400	Tan-Oak Forest	2.8	1	0.8%	1	0	2	**4**
37810	Buck Brush Chaparral	8.3	1	2.5%	1	0	1	**3**
71310	Open Foothill Pine Woodland	1.8	1	0.6%	1	0	1	**3**
82310	Alluvial Redwood Forest	4.3	1	0.7%	1	0	1	**3**
84110	Coast Range Mixed Coniferous Forest	1.6	1	0.9%	1	0	1	**3**
37530	Montane Ceanothus Chaparral	0.2	1	0.5%	1	0	1	**3**
84140	Coulter Pine Forest	2.8	1	0.0%	1	1	-2	**1**
37510	Mixed Montane Chaparral	0.1	1	0.0%	1	0	-2	**0**
37900	Scrub Oak Chaparral	1.0	1	0.9%	1	0	-2	**0**
81320	Canyon Live Oak Forest	6.5	1	0.8%	1	0	-2	**0**
84130	Coast Range Ponderosa Pine Forest	1.8	1	0.0%	1	0 to 4	-2	**-1 to 3**

4.0 Discussion

The analyses performed in the Bay Area Gap Analysis produced new information about the current status of Bay Area conservation, and can help determine regional conservation priorities. The open space stewardship layer provided an improvement in the data available about open space protection in the Bay Area. Potential uses for this information are discussed, along with recommended next steps for applying gap analysis to regional conservation decisions.

4.1 Representation: Successes and Gaps

The representation analysis sought to assess how well the current system of open space lands in the Bay Area protects natural communities (and by extension, regional biodiversity). Protected open-space lands make up 16.1% of the Bay Area (Status 1 and 2 combined). Although this degree of protection is slightly lower than the statewide average of 18%, it is relatively high among California urban areas (Davis et al. 1998).

Altogether, at least 42% of the region is urban, agricultural, or dominated by exotic species (Table 3). Almost a third of the Bay Area consists of non-natural land cover types. The most dominant natural community in the Bay Area, non-native grassland at 12%, is dominated by exotic and annual plant species rather than native vegetation and is primarily utilized for livestock grazing.

Twenty-four of the 62 natural communities that occur in the Bay Area, or 38%, are adequately protected at a target level of 20% (Table 7). These protected communities represent successes in planning regional open space lands, especially in light of the intensive development of the Bay Area. The remaining 38 natural communities, or 62%, are conservation gaps in need of further protection (Table 6).

The high number of under-protected communities is in keeping with the results of other gap projects. New Mexico's gap analysis found that 25 of 29 (or 86%) natural land covers were not protected at a 20% level. In Oregon, 19 of 30 (63%) natural communities had less than 10% protection in Status 1 or Status 2 lands (and two more at less than 20%). A 1997 gap analysis of Costa Rica, a country known for its extensive protected area system, found that 11 out of 23 (48%) biotic life zones failed to meet the minimum 10% target set by investigators (Powell et al. 2000). And the California Gap Analysis Project found 73 out of 194 natural communities at less than 10% representation and 46 additional communities at 10-20% representation, for a total 61% of natural communities below the 20% protection level.

Based on the suggested representation thresholds and the representation analysis in Table 7, it is a simple calculation to establish a target acreage for protection of each under-represented natural community. For example, protecting an additional 847 acres of Blue Oak Woodlands would bring its total protected area to 20%. However, the coarse scale of the data means that this number should be considered as a rough estimate. For this reason, calculation of target protection acreages has not been included in this report.

Nevertheless, readers may perform these calculations and use them as approximate targets.

As an alternative to the two target levels used here (100% for communities with documented historic declines, and 20% for remaining communities), readers may explore the effects of setting their own target levels of protection by referring to Appendix 8. Applying different target levels could serve as a springboard for the discussion of adequate protection in the region.

The presence of 38 under-represented communities in the Bay Area constitutes a daunting challenge. Why are there so many protection gaps? Several factors contributed to the current situation. Historically, protected lands in the Bay Area were selected for some reason other than protecting the range of natural communities. Early land protection often focused on public recreation, watershed protection, maintenance of heavily hunted wildlife populations (Caughley and Gunn 1996), or scenic protection. It is not surprising then, that the Bay Area's protected lands fail to conserve the full spectrum of natural communities; they were not designed to do so.

Furthermore, historic approaches to conservation have been largely reactionary (Ludwig et al. 1993). Conservation organizations responded to immediate threats of the loss of resources or to the opportunity to acquire specific tracts of land. Often there was little other information on which to base decisions. Only recently have improvements in technology made it possible to map resources with reasonable accuracy, conduct spatial analyses, and share information about protection levels across regions.

New approaches such as gap analysis will not entirely replace traditional decision-making processes in the conservation field. The unique circumstances that surround each decision require evaluation by knowledgeable people. But gap analysis and other analytical techniques can inform conservation decisions and balance the shortcomings of traditional approaches in selecting conservation sites.

4.2 Prioritization: Preliminary Assessment

Regional endemism, development risk, rarity, and statewide protection were the criteria used to prioritize communities for conservation action. A discussion of these factors follows.

4.2.1 Endemicity

Conservation of communities that have a greater proportion of their cover in the Bay Area will largely depend upon decisions made by Bay Area conservation planners in the next decades, especially as regards eight gap communities that have at least 25% of their statewide extent in the Bay Area:

- Northern Claypan Vernal Pool
- Coastal Prairie
- Northern Coastal Salt Marsh

- Coastal Brackish Marsh
- Valley Needlegrass Grassland
- Coast Live Oak Woodland
- Coast Live Oak Forest
- Mixed North Slope Cismontane Woodland

4.2.2 Development Risk

The imminent threat of chainsaws, bulldozers or other catastrophic impact has spurred the protection of many natural areas. In contrast, when no immediate threat looms, even candidate protection sites considered highly valuable may be postponed. The Greenbelt Alliance data illustrated the patchiness of development probability and how this patchiness results in variable threats to communities. The under-represented communities are not equally threatened by development. A few are highly threatened. Many are not threatened at all or face low levels of development risk within the 30-year projection period, depending on the coincidence of their distribution with the development risk distribution. Communities with small, localized distributions (either naturally narrowly distributed or as remnants of previously larger distributions) dramatically illustrate this effect. For these localized communities, those found in rough, rugged terrain, or areas unattractive to humans are typically not under immediate threat (e.g. Mixed Serpentine Chaparral), while those found in areas attractive to humans are intensely threatened (e.g. Venturan Coastal Sage Scrub).

Four of the eight gap communities that have already lost 80% of more of their historic extent are among those facing significant development pressure. If these communities continue to lose area over the next decade, they risk becoming too small or too isolated to maintain habitat value or populations of important species:

- Coastal Prairie
- Coastal and Valley Freshwater Marsh
- Northern Coastal Salt Marsh
- Great Valley Cottonwood Riparian Forest

Although development is not the only threat to community persistence, the outlook is more positive for the remaining gap communities not facing local development pressure. Lacking development pressure, there is time to plan for the most strategic acquisitions. Equally, lower development interest should translate to acquisition costs somewhat more moderate than prices typical of the Bay Area.

4.2.3 Rarity

The role of rarity in conservation planning is complex – three different types of rare communities exist, and each has different implications for conservation. The first type is comprised of communities with very restricted distributions. These are inherently more vulnerable than communities with wide distributions, but many of these rare communities occur in remote areas and are not currently threatened. Noss et al. (1995) note that the ecological role of such rare communities in the surrounding ecosystem may be minor.

The second type of rare community is the community that is now rare because it has declined significantly from its historically larger extent. The eight communities identified in Section 3.1.3 as greatly diminished fall into this category and all remain highly threatened by continuing conversion of habitat to human use. These once-extensive communities often played significant roles in the function of entire ecoregions when widespread (Noss et al. 1995), but as their area declined, that function has been disrupted or lost. Rarity is a very strong argument for prioritizing the conservation and restoration of these declining communities. Finally, some communities may be locally rare, but common elsewhere. Because the analysis examines a region delimited by political, rather than ecological boundaries, a number of communities exhibit this pseudo rarity, showing small extents in the Bay Area but larger extents elsewhere in the state. This type of rarity should not be a prioritizing criterion. Because the Bay Area analysis used the NHD rankings for the entire state of California, only the first two types of rarity discussed above were incorporated into the prioritization analysis.

4.2.4 Statewide Protection

Of the 38 communities under-represented in the Bay Area, five are well represented elsewhere in the state. These are:

- Scrub Oak Chaparral
- Mixed Montane Chaparral
- Canyon Live Oak Forest
- Coast Range Ponderosa Pine Forest
- Coulter Pine Forest.

Although these communities are under-represented in the Bay Area, it is difficult to argue that a community well protected in the rest of the state should remain a local conservation priority when so many communities require attention. This does not mean that these communities should be entirely removed from the local conservation agenda. Communities should be protected throughout their distribution to represent genetic variation and guard against environmental stochasticity. However, it does diminish the urgency. This was reflected in the prioritization analysis via the statewide representation score.

The prioritization analysis included in this report is not a substitute for additional conservation planning. The prioritization analysis seeks to direct our attention to the communities that are currently most imperiled. Prioritization addresses the order in which—or when—these lands should be protected. Systematic planning describes where new protected lands should be located.

4.3 Next Steps

With this preliminary gap analysis, the Bay Program has completed a vital step in comprehensive regional conservation planning. Before moving ahead with the follow-up conservation planning recommended in this report, it would be worthwhile to reexamine the question of adequate representation. Although definitive answers on adequate representation will remain obscured by our lack of understanding, improved

representation goals can and should be established. Reconsideration of the representation levels needs to evaluate all of the points addressed in this report:

- Is 20% adequate representation for most communities?
- What is the appropriate representation level for species or communities that need fine-filter consideration?
- How might representation levels be adjusted for communities that have experienced significant declines but less than the 80% proportion referenced in this report?
- Should adequate representation be based on a percentage of extent or a different method?

A regional working group, composed of local resource experts and regional policy makers, would be appropriate for the task of refining representation goals.

This gap analysis focused on *what* by identifying the communities that require additional protection. The prioritization analysis focused on *when*, by identifying the communities most at risk. The question of *where* remains. The comprehensive planning process is the appropriate point to consider where new protected lands should be located and incorporate consideration of the many factors that contribute to ecological integrity—size and configuration, connectivity, habitat condition, etc.

Resources diverted to conservation planning are well used. Priority conservation areas must be determined by objective criteria and quantified goals. While acknowledging the human bias for charismatic natural communities such as wildflower fields and scenic mountains, we cannot ignore the biological value of smelly swamps and dry barren scrub. If conservation areas continue to be selected based on opportunism, anthropocentric preference, and inaccurate perceptions of need, the goal of protecting the full spectrum of biodiversity will likely not be achieved.

A regional planning effort will greatly increase efficiency of resource allocation. Local planning efforts bring valuable insights about the location of resources but frequently lose sight of large-scale effects and the overarching regional needs. Statewide planning efforts, in contrast, are generally successful at capturing large-scale values and the "big picture" but cannot consider local details. The regional planning process should balance local interests with statewide interests such that the final outcome makes sense at the regional level. The regional plan does not preclude local groups from pursuing additional or different local objectives nor does it preclude a statewide agency from pursuing state level objectives. The process is essentially that of determining where solutions can be implemented with the best balance of ecological principles and cost-efficiency.

The resources needed to carry out this planning process are already available. The many local land protection organizations in the Bay Area will bring essential knowledge and resources to the table. A rich literature exists (Appendix 10) covering both the theoretical foundation of conservation planning as well as the practical aspects of conducting a planning process. Various computer applications are available (Appendix 10) to model viable population sizes and find the most efficient spatial arrangement of protected areas.

Additional spatial data is available for wetlands, vernal pools and other communities that are not well mapped by the California Gap Analysis Project land cover layer, as well as other useful data such as the recently completed *Missing Linkages* layer that considered migration corridors. The Bay Area is fortunate to possess numerous experts on natural communities, ecosystem processes, conservation biology and landscape ecology. All of these information sources can be incorporated into the planning process.

Upon completion of the planning process, the Bay Program and its local and regional partners will have a road map for action that is comprehensive in scope and incorporates the best available science. This tool will assist the Bay Program and its partners to proactively target the most critical and cost-effective areas for acquisition.

Naturally, protection efforts will not cease while the planning process is underway. In the interim, the data developed and used in this project can serve several functions. Any regional conservation organization can use the data to identify the areas within its jurisdiction that contain under-represented communities and nearby protected lands that might be cost-effectively expanded to incorporate these communities. Alternatively, when a site is considered for acquisition, it can be evaluated against the land cover layer to determine the natural communities contained, the amount of each that will be protected, and the priority level.

4.4 Conclusions

This project added to the already impressive knowledge base on Bay Area conservation. By establishing quantified representation goals, the project clearly defined regional biodiversity conservation success and calculated the Bay Area's progress toward that success. Using a 20% target level of protection for most communities, the task of regional biodiversity protection is 38% accomplished. There is less need to expend additional resources on the 24 communities that are adequately protected than on the 38 under-represented communities. Protecting additional area for each under-represented community will be a significant step toward conservation success. The prioritization analysis, with its snapshot of threats and rarity, helps to schedule these future steps. Conservation of communities that are largely endemic to the Bay Area will rely upon decisions made by Bay Area conservation planners in the next decades.

Some of the under-represented communities are well known and the recipients of much conservation effort, such as the wetland communities Coastal Brackish Marsh, and Coastal and Valley Freshwater Marsh. The analysis results confirm the appropriateness of those efforts. But the analysis also identified as gaps several communities that are less recognized by the public. Some of these are highly threatened. The communities Coastal Prairie, Monterey Pine Forest and Northern Claypan Vernal Pool scored higher in the prioritization analysis than did these two marsh communities. Mixed Serpentine Chaparral, Venturan Coastal Sage Scrub, Great Valley Cottonwood Riparian Forest and several other types also scored very high. These communities are less widely recognized as critically imperiled than are the wetland types and consequently are receiving less attention.

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Glossary

Clipping: An operation applied to a layer in a GIS. Features of one layer are clipped according to an overlaid set of polygons. The operation is analogous to using a cookie-cutter to select all of the features inside the cutter and to discard the features outside the cutter.

Endemic: Plants or animals that are restricted to a particular area that is defined by the speaker. e.g. a natural community or a geographic area ranging from the size of counties to continents.

Hectare: Unit of area composed of 10,000 square meters. Equivalent to 2.47 acres.

Land Cover: Actual surface covering of the land at a given moment. Types may include rock, water, grassland, forest, pavement, etc. Natural communities are a subset of land cover classifications.

Land Use: The human use or economic activity conducted on the land surface. Some examples of land use types are agriculture, urban, suburban, and forest plantations.

Large-scale/small-scale: These terms have opposite meanings in different disciplines, which can cause confusion. In ecology, large-scale refers to events or effects that occur at or can be measured over large areas of the earth. Conversely, small-scale refers to events or effects that occur at or can be measured in small areas. The meaning of large-scale and small-scale in cartography is opposite that in ecology. Large-scale typically refers to maps at the 1:25,000 scale or less. Medium-scale typically refers to maps at the 1:100,000-1:250,000 scale. Small scale typically refers to maps greater than 1:250,000 scale. A "small-scale" map depicts a large area. See "scale."

Layer: Also called a "theme." A set of geographic features (polygons, lines, or points) of the same type, along with their attributes. For example, a digital county parcel map would be comprised of polygons representing land units and attributes could include owner's name, acreage, date of last sale, etc.

Minimum Mapping Unit: The smallest size area to be mapped as a discrete area.

Natural Community: An assemblage of species that recurs on the landscape under similar environmental conditions and the ecological processes associated with it.

Polygon: A map feature that has area and cannot be represented as a point or line. Examples of polygon features are counties and lakes.

Resolution: A "coarse resolution" classification of land cover types may map only grassland and forest, while a "fine resolution" map of the same area may delineate many types of grasslands and forests. The second type has greater resolution than the first.

Scale: The relationship between a distance portrayed on a map and the same distance on the Earth. Scale is frequently represented as a ratio, e.g. 1:100,000 or as a fraction, 1/100,000. In this example, 1 inch on the map would represent 100,000 inches of earth surface. In cartography, the smaller the denominator, the larger the scale, e.g., 1:24,000 is larger than 1:100,000.

Shapefile: A proprietary file format used in ArcView GIS to store data.

Vegetation: The collective plant species in an area.

Vegetation Classification: The process of categorizing vegetation into repeatable and consistent classes.

Notes

[1] The Bay Area is commonly defined as the combined land area of the following counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma. This report adheres to this definition.

[2] The Bay Area Open Space Council is a collaborative program of public and non-profit agencies and organizations, providing regional leadership and expertise for the preservation and professional management of important open spaces in and around the cities of the San Francisco Bay Area. The membership of the Council includes approximately 50 agencies and organizations working toward preservation of open space lands in the Bay Area.

[3] The Bay Area analysis required clipping the land cover layer to the perimeter of the nine-county region that comprises the Bay Area. This clipping operation bisected all of the polygons that intersect the perimeter, so that each polygon was converted to two progeny polygons, one inside the study area and one outside.

Recall that each polygon can be attributed with a primary, secondary, and tertiary community type and the proportion of each type in the polygon. However, the locations of the secondary and tertiary types within the original polygon are not specified. For example, consider a parent polygon that has 75% community A and 25% community B. Community B is found primarily in the northern portion of the polygon. If the polygon is split along an east-west line, very little community B will be found in the southern progeny polygon. The assumption that the progeny polygons have identical types and proportions introduces an unknown amount of error into the analysis of those polygons.

An alternative method was sought to eliminate this error. Using the GIS software, it is possible to select and analyze all of the polygons that are found completely within the nine-county defined perimeter, and ignore the polygons that intersect the perimeter. However, this removed large tracts of area from the analysis, a result that was less satisfactory than the first method.

The California Gap Analysis Project conducted two types of sub-state analyses that required a clipping step identical to that used in the Bay Area analysis: 1) regional analyses based on ecoregions; and 2) individual county level analyses. Upon examining the state project documentation, it was determined that the state project elected to ignore the error introduced by clipping polygons. Therefore, the same approach was used in the Bay Area analysis.

[4] GreenInfo Network is a non-profit, public service, Geographic Information Systems organization based in San Francisco, California. For more information, please see http://www.greeninfo.org

[5] Appendix 2 contains a flow chart of decision rules developed by the National Gap Analysis Program to assist in classifying lands into the above categories. This flow chart also provides useful clarification of the status category terms.

[6] The goal of this step was to calculate the extent of each natural community within each protection level across the region. Due to the construction of the open space stewardship layer, this was not a straightforward calculation. Within the open space stewardship layer polygons are designated as status levels 1, 2, 3 or 4. All of the area outside of the polygons also represents Status 4 area and this prevented a simple intersection of the two layers. Instead, Status 1 and 2 lands in the open space stewardship layer were selected. These were then "erased" from the polygons of the land cover layer, using the Xtools extension developed by Mike DeLaune of the Oregon Department of Forestry. The remaining polygons represented all of the Status 3 and 4 areas (or the unprotected areas) of each natural community. The total for each natural community type was again calculated by summing the area of each community. These unprotected totals for each community were subtracted from the Bay Area-wide totals calculated in the previous step. The difference was the amount of protected area for each natural community. This number was then compared to the total area of each natural community and converted to a percentage in protected status as the final step.

[7] The Noss et al. 1995 findings were based on a review of the literature documenting community declines. Additional communities with significant declines, but without published documentation, may exist.

[8] The California Gap Analysis Project based its prioritization on the NHD rankings and other factors.

[9] Greenbelt Alliance's mission is to protect the Bay Area's greenbelt and improve the livability of its cities and towns. For more information, please see http://www.greenbelt.org.

[10] The intersection operation was performed with the Xtools utility developed by Mike DeLaune of the Oregon Department of Forestry.

[11] The initial representation analysis identified 36 communities in the Bay Area with less than 20% representation. Of these 36, 1 was tamarisk scrub (community code 63810). Tamarisk scrub is a natural community, but tamarisk is also an invasive exotic species. Since it is not a conservation target, it was eliminated from the remainder of the analysis. A second community, Central Coast Cottonwood-Sycamore Riparian Forest (community code 61210) was also eliminated from further analysis. This community had the smallest mapped extent in the Bay Area (0.2 km^2) as well as the smallest proportionate share of statewide distribution (0.3 of the statewide extent occurs in the Bay Area) and it was the only community in the regional analysis that lacked a single polygon fully contained by the study area. The community occurs in the Bay Area as a thin ribbon at the far southern edge of San Mateo County, which was clipped from a larger polygon of the community

located primarily in Santa Cruz County. Santa Cruz County is outside the Bay Area as defined in this report. This community remains a conservation target but action can be more appropriately taken by Santa Cruz County and other counties farther south.